TESTS FOR CANTON AND ABACA[1]

Canton fiber has attracted the attention of the public because of the alleged practice of mixing it with abacá. This practice is of course detrimental to the abacá industry.

Hanks of canton and abacá of ordinary size may be easily distinguished from each other. The trouble comes in when canton is intimately mixed with abacá. The government fiber grading regulations require that abacá which is adulterated with canton in such a way as to make it impracticable to separate the two should be graded as canton. But "neither Government fiber inspectors nor private interests have the necessary tests nor knowledge for unmixing them". (The quotation is from Doctor Sherman's article, published in the local press.)

It will presently be shown that canton as it is prepared for the market may be distinguished from abacá even if the two are intimately mixed.

There are several species of plants belonging to the banana family which are known under the name of *Canton* but only *Canton-pute* is stripped and marketed in large quantities. Canton is used for *Canton-pute* in the following discussion.

On account of the weakness of canton fiber, it can be stripped with profit only in the lower grades. Fiber prepared in this way carries with it some foreign materials collectively known as pulp. Under a microscope of sufficient magnifying power, it may be seen that this pulp consists of several kinds of cells, the most interesting of which in this connection is that which is botanically known as *stegma*, plural *stegmata*. The stegmata are silicified cells which look like small bricks with a small circular excavation on one surface. They are found among plants belonging to the palm and banana families. This latter family includes both canton and abacá.

Fiber from some fifty varieties of abacá growing in the College of Agriculture, Los Baños, have been studied together with authentic samples of canton fiber from the Bureau of Agriculture and fiber prepared from canton plants growing in the experimental grounds of the Bureau of Agriculture at Singalong. The fiber is prepared for examination under the microscope by macerating it in warm nitric acid to which a little potassium chlorate has been added.

One characteristic of canton fiber from the Bureau of Agriculture and of that prepared from the canton plants growing at Singalong is that the stegmata are abundant. This is not true of all the abaca varieties studied.

[1] Experiment Station constribution No. 377. Received for publication, July 14, 1926.

In abacá the stegmata are scanty and in some cases it may require a number of preparations to discover them.

The stegmata of canton are conspicuously larger than most of the varieties of abacá, measuring around 0.0339 mm. in length. There are only a few varieties of abacá the stegmata of which would compare with those of canton in size, but the fiber from these varieties may readily be distinguished from that of canton by the characters which are discussed below.

The wall of the fiber cells of canton is comparatively thinner than most varieties of abaca. By careful manipulation, the strand of a fiber, almost intact, may be examined under the microscope. Then the cells in a single strand may be examined and the thinner walls of the fiber cells from a strand of canton may then be observed.

But the characteristic which is of greater importance in identifying the fiber of canton is the *pit*. This is a botanical term applied to the unthickened portion of the cell wall. Under the microscope, it appears like a hole through the wall. The pits of the fiber cells of abacá and canton are elongated in form but they differ in size and especially in the angle which they make with the long diameter of the cell. The pit of canton is almost parallel to the long axis of the cell and this is only true of a few varieties of abacá. Most varieties have pits which are at more or less sharp angle with the fiber cells. Those varieties whose pits are almost parallel to the longer dimensions of the fiber cells may be distinguished from canton by the dimensions of the fiber cells, especially the thickness of the wall, and by the dimensions and abundance of the stegmata.

The above tests would be sufficient in most cases to verify the presence of canton fiber in abacá. But these tests require the use of a high-power microscope and can be satisfactorily performed only in the laboratory. The following tests may be performed at the place of inspection.

Since the fiber of canton is weaker than that of abacá, the suspicion of an observer may be aroused by testing with his hands strands of the sample under examination. A more reliable method would be by testing with a suitable machine the tensile strength of the strands in a hank of the supposedly adulterated abacá. In this case it would be necessary to test only a single strand at a time.

The following test may be termed the "ash test". This test is the most practical and should precede all the microscopical tests which are confirmatory. It has been found that the appearance of the ash of canton is different from that of the ash of all the varieties of abacá studied. It must be understood in this connection that the test is to be performed also with the lower grades of abacá, that is, the grades in which canton appears in the market. The difference is not so easily described but may be easily learned after a few trials. The direction for testing follows:

Take a dry sample a few centimeters long of the fiber under examination. Hold one end of the sample with one hand and with the other apply a lighted match to the free end of the sample. The burning of each strand may then be closely observed. The canton strands burn more easily than the abacá and with almost white ash. The abacá strands produce a darker ash. The ash of the abaca strands shows a finely fibrous structure which is not true of canton.

A full illustrated report on this subject, with extensive data, is being published elsewhere.

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The Romans who understood the essentials of good agriculture reduced them to three, namely, a good seed bed, good seed, and good tillage. It would certainly be poor economy to prepare a good seed bed and then plant poor seed. That would not give the seed bed a fair chance. It would be equally poor economy to plant good seed in a good seed bed and then give it poor tillage. Then neither the seed bed nor the seed would have a fair chance.

More important than any or all of these factors combined, however, is another factor, namely a good farmer. Everybody knows that it would be poor economy to grow excellent grain to feed to scrub stock. That is not giving the feed a fair chance. It is even worse economy to grow good grain and good pork and beef to feed to scrub men. That is not giving the food a fair chance. By scrub men I mean men who, however rich they may be, have no desires, ambitions, or interests beyond the mere gratification of their sensual appetites.

The final test of good agriculture, therefore, is the growing of good men and women who are thoroughbreds in the real sense of the word.—T. N. CARVER.

—*The Prairie Farmer* (Illinois).

STUDY OF THE FLOWERING HABITS AND FLOWER CHARACTERISTICS OF THREE VARIETIES OF SUGAR CANE[1]

TORIBIO MERCADO

WITH ONE TEXT FIGURE

To carry on hybridization work successfully, it is necessary for a hybridizer to understand in detail the flower characteristics and flowering habits of the plants which he is to use. Such knowledge will serve as a reliable guide in his work and prevent his using hit-or-miss methods, thus saving much time and expense. The present work deals with the flowering habits and flower characteristics of three important varieties of sugar cane now growing on the College Farm. These varieties are Negros Purple, Badila, and C. A. C. 87.

The data given in this paper was taken from an experiment performed in the Plant Breeding Nursery of the College of Agriculture during the 1924-1925 and 1925-1926 sugar cane flowering seasons.

MATERIALS AND METHODS

It was proposed in this experiment to study the flowers of plant and ratoon canes of four sugar cane varieties; namely, Badila, Luzon White, Negros Purple, and C. A. C. 87. Of these varieties, Luzon White failed to arrow, consequently, three were used.

EXPERIMENTS AND RESULTS

Field study of flowers

The 1925-1926 sugar cane flowering season commenced on August 15, 1925, and lasted until about the first part of February, 1926. The Uba cane was the earliest to flower, and the C. A. C. 87, the latest. As soon as the top of the arrow emerged from the last leaf sheath of the cane stalk, the study of the flowers was made. Observation on Negros Purple was begun October 27, 1925, on C. A. C. 87, November 6, and on Badila, November 16. Observations were made of the general characteristics of the arrows, the age and date of flowering, manner of opening of flowers, and dehiscence of anthers, agents of cross pollination, percentage of open and closed flowers, habits of

[1] Thesis presented for graduation, 1926, with the degree of Bachelor of Agriculture, from the College of Agriculture, No. 229; Experiment Station contribution No. 378. Prepared in the Department of Agronomy under the direction of Dr. N. B. Mendiola.

A part of this paper entitled, "Training sugar cane plants for convenient pollination work," was published in advance in this journal, **14**: 539-540. (*Plate I. Fig. 1-3*). 1926.

This thesis was awarded the Class of 1925 Medal for best thesis presented in 1926.

pollination and how long it took an arrow to mature. The results obtained are shown in tables 1, 2, 3, 4, 5, 6, 7, and 8.

Table 1 shows the relative date and age of flowering. These data were obtained by noting the date of planting or cutting to ratoon and the date of first flowering of each of the varieties studied. The age of the cane from planting or cutting to ratoon to first flowering was then computed.

Table 2 gives the average length of time from shooting to the full emergence of the arrow, to pollination, and to the ripening of the arrow. A number of individual stalks was used for this purpose. Each arrow was tagged before the tip came out. Daily examination was made to determine the date of emergence of the tip, the date of opening of the first flowers, the date on which most flowers opened, and the date on which arrows showed sign of maturity.

Table 3 presents the date and time of opening of flowers and the general weather condition on each day of observation. The data were obtained by selecting a healthy arrow of each variety studied and labeling it. As soon as the tip of the arrow was out, each spikelet at each node was tagged with a piece of thick paper and all the spikelets being studied were numbered consecutively from the tip. The flowers in the selected spikelet were counted. Very early in the morning and at intervals of two or three hours during the day, the number of open flowers was ascertained. After a flower opened and was counted it was cut off carefully from the spikelet with a pair of small scissors. The other spikelets were labeled and numbered as they came out. This observation continued every day until the last flower in the last spikelet opened. The total number of flowers that opened in the spikelet was found, and the percentage of open flowers was computed.

Table 4 gives the duration of opening of flowers. Table 5 gives the comparative production of open flowers. Table 6 gives the date and time of dehiscence of anthers, the time being noted during the observation of the opening of the flowers.

Effort was made to determine the number of pollen grains scattered around the plants. In doing this five glass plates were used. Each plate, coated with vaseline on the upper side, was placed on supports made of thin pieces of boards and held in position by pasting. The supports were of a length nearly as high as the cane plant. Very early in the morning before the discharge of pollen grains began, the plates were placed on the windward side of the plant. The plates were set in a row one meter apart, at a distance of one meter from the mother plant. In the afternoon of the same day the plates were removed and were examined under the low power of the microscope for the pollen grains caught. Table 7 gives the number of pollen grains caught in this way from the air at a certain wind velocity.

After pollination had occurred, freshly opened flowers were examined by means of a hand lens for the pollen grains present on each stigma. Several spikelets of the newly opened flowers after pollination had occurred

were taken carefully to the laboratory for microscopical examination. The stigmas were removed with care from the other parts of the flowers, placed on the slides and mounted under the low power of the microscope. By adjusting the slides and focusing the microscope at different times on different parts of the stigma, all the pollen grains found were counted from one end of the stigma to the other. Insects found during the pollination period were observed, representatives were caught and identified.[2]

Table 8 shows the percentage of millable stalks that flowered in the three varieties studied.

Laboratory observations

Young arrows were taken to the laboratory for the study of the number of flowers in the arrow, the number and kinds of pollen grains in the anther, size of pollen grain, anthers, and stigmas, and the germination of pollen grains. The results of these observations are shown in tables 9, 10, 11, and 12.

Table 9 shows the average number of flowers to the arrow. Tables 10 and 11 give the approximate number and kinds of pollen grains produced per anther, per flower, and per arrow. To find the number and kinds of pollen grains in a variety, a healthy unopened ripe anther was selected and, with scissors, cut carefully from the flower. The anther was then mounted on a slide and a drop of iodine solution placed on it. By means of two dissecting needles the anther was pressed a little on a slide to discharge some of its pollen grains. On these a drop of iodine solution was applied. The partly pressed anther was then transferred to another slide and iodine solution was added again. The first slide was mounted under the low power of the microscope for examination of the number and kinds of pollen grains. The fertile and sterile pollen grains were counted separately. This process was repeated continuously until all the pollen grains the anther contained were counted. The number of pollen grains per flower was found by multiplying the average number of pollen grains per anther by the number of anthers in the flower. The number of pollen grains per arrow was then computed by multiplying the number of pollen grains in the flower by the average number of flowers to the arrow. Table 11 also shows the percentages of fertile and sterile pollen grains produced per anther in each variety. Table 12 contains the data on the relative abundance of pollen grains found on each fresh stigma.

Three methods were tried in an effort to determine the best means for germinating pollen grains in this study. The first method consisted in the use of sterilized sugar solutions of different strength. Pollen grains failed to germinate in these solutions. Another method, advocated by some sugar cane breeders, was the use of stigmas of live plants. Of the plants recom-

[2] Identification of the insects was made by Dr. L. B. Uichanco of the Department of Economic Entomology.

mended, the stigmas of *Datura fastuosa* variety *alba, Carica papaya, Hibiscus vitifolius, Gynandropsis pentaphylla,* and *Thespesia populnea* were used. Satisfactory results were not obtained. Stigmas of tobacco were available only at the end of the flowering season and were not used. The third method used was that of Cottrell-Dormer (1924) with slight modification. The process followed was to dissect very early in the morning, before the anthers dehisced, a number of newly opened flowers. The ovaries with stigmas were placed in small damp filter paper cells on glass slides. These cells were made by cutting the filter paper about the size of the cover glasses and punching a small hole in the center. One was placed on a slide and then dampened with water. The ovary with the two stigmas were placed in the hole and were examined under the microscope to see that no pollen grain had found its way to the stigmas. If pollen grains were present, the stigmas and ovary were discarded. The pollen grains were then dusted on the pollen-free stigmas by holding a ripe anther over the stigmas by means of a needle and piercing it slightly with another needle. The stigmas were then examined to see that pollination had taken place. The cover glass was placed over the hole and the slide was set aside for a day. The filter paper was kept moist by putting a drop of water on it at intervals of one hour. The stigmas were re-examined for the number of pollen grains that germinated after two or three hours had elapsed. The results of this experiment are shown in table 13.

During the 1925-1926 cane flowering season, some cane flowering varieties arrowed earlier than others. C. A. C. 87 began flowering on November 4, and Badila, two weeks later. By the time the C. A. C. 87 was in full bloom, Badila was just beginning to send out its arrows. If hybridization work is to be accomplished with these or other similar canes as parents, the preservation of pollen grains for a certain length of time is a very necessary part of the work. The variety used in this experiment was C. A. C. 87 and the work was performed on November 17, 1925. In this study there were two methods used. The first one was the use of a bamboo crate where the arrow, previously wrapped with oil paper, was placed. The stalk was cut under water and then the base was immediately stuck into a ball of puddled clay. The results of this trial were rather unsatisfactory as the ball of clay needed constant watering to keep it moist and if left rather dry it cracked. The second method was similar to the first except that different kinds of materials were used. The crate was a double layer of banana bracts. The crate was tied tightly and supported by a strong pole to prevent the stalk from breaking. The whole banana crate was wrapped with one layer of dry banana leaves about 1.2 centimeters in thickness. It was found that the end of the bracts in the first layer was dried.

Table 14 shows the comparative size of pollen grain, anther, and stigma of the three varieties studied.

Table 15 gives the temperature inside and outside the bag during the experiment of bagging cane arrows.

Cultures

Preservation of cane stalks in solutions. On account of the unsatisfactory results obtained during the 1924-1925 flowering season in selfing a variety of cane by bagging arrows in the air, efforts were made to grow cane stalks in different solutions. Chlorine water, dilute HCl, CH_3COOH, H_2SO_4, and H_2SO_3, charcoal, normal salt mixtures, $(NH_4)_2 SO_4$, $(NH_4)_3 PO_4$, ferric citrate, and NaCl were tried. Several varieties of canes representing the thin and thick types were used. Several trials were made but unexpected rain and wind injured the plants so no satisfactory results were obtained.

Collection and storage of tassels. The method given by Jennings, as cited by Alexander (1925) and Venkatraman (1925), with some additions as circumstances demanded, was used in collecting tassels in the flowering season. At first the ripening of the cane arrows was observed in the field. The arrows for germination were tagged and collected at different ages beginning when the top florets fell off. Collecting was done only on clear sunny days, from noon to afternoon, if possible, as less moisture is present in the arrow at this part of the day. When seed plots were ready for use in planting, the collecting was done early in the morning irrespective of the condition of the day. The seeds were sowed immediately after collection. When arrows were collected dry, they were placed in bundles in sacks or bags the mouths of which were left open for several days. Labels were then placed inside and outside of each sack or bag to prevent confusion. The stalks in the arrows were removed three or four days later so that moisture in them would not dampen the seeds. The fuzz was then placed in the same container ready for planting or storage.

Planting the seeds in seed boxes. The method used in planting seeds was that which has been used in this College since 1919. The fuzz was spread uniformly on the surface of the fine soil in the box, constituting a wet layer of about two millimeters in thickness. The seeds that were important were planted very thinly. Two kinds of soil were used in this study—the compost and the ordinary soil. The seeds were watered very carefully that they might not roll together. They were watered morning and afternoon during the first three or four days to wet all the fuzz thoroughly and to start germination. After germination had taken place, they were watered only once a day. To obtain the greatest percentage of germination the seeds were covered with glass. A cloth cover was tried, but was found unsatisfactory. Table 16 shows the number of seedlings obtained from each arrow planted from ratoon and plant canes.

DISCUSSION OF RESULTS

Relative date and age of flowering. Although two or more varieties were planted on the same date, in the majority of cases the flowering period was different, as shown in table 1. There were three plots of Badila used. One was planted on September 24, 1924, the second on January 31, 1925, and the third plot cut to ratoon on January 29 of the same year. The flowering period in these three plots began at the same time, on November 16, 1925. C. A. C. 87 which was planted on January 1, 1925, in one plot and cut to ratoon on January 17 on another, flowered on November 4 of the same year. Negros Purple, which was planted October 24, 1924, flowered on October 27, 1925. During this season, hard slender canes flowered earlier than thick soft ones. In the 1925-1926 season the flowering of the three varieties studied lasted from October 27, 1925, to February 10, 1926, a period covering approximately 106 days, or about three months. The active flowering period, however, of the three varieties was from October 27 to December 10 of the same year. It was found that the age at which the sugar cane plant flowered did not vary according to the time the cane was planted. Badila canes that were 291, 428, and 289 days old when planted, flowered at the same time. C. A. C. 87 plants which were planted in different plots and at different periods flowered at about the same time. The 368-day old Negros Purple arrowed on October 27, 1925. The flowering period of Badila was from November 16 to December 20, 1925; C. A. C. 87 from November 4, 1925, to February 6, 1926; and Negros Purple from October 27 to December 20, 1925.

Time from appearance of the tip of the arrow to full emergence, to pollination, and to ripening of seeds. From data shown in table 2, it is evident that the length of time from shooting to full emergence of the whole arrow, to pollination, and to ripening of seeds varied according to variety. Ratoon and plant canes of one variety had the same manner and time of shooting of arrow. It took about ten days for Badila to send out its whole arrows, eleven days for C. A. C. 87, and eight days for Negros Purple. As to pollination, Badila gave its first pollen about the fifth day, C. A. C. 87, the fourth day, and Negros Purple, the seventh day after the appearance of the tip of the arrow. With the Badila, most flowers opened in about seven days after shooting, with C. A. C. 87, ten days, with Negros Purple, twelve days. Seeds of Badila began to ripen about 23 days after exposing the tip of the arrow, of C. A. C. 87 in 22 days, and of Negros Purple in 21 days.

From these data it is clearly seen that seeds of Negros Purple ripened first, C. A. C. 87 second, and Badila third. This finding has significance under Los Baños conditions for, knowing the best time for harvesting each variety, the breeder can estimate the proper time to germinate the seed of each variety.

Characteristic of arrows in the field. In general, viewed from a distance, cane arrows have a cone-like shape in appearance, with slightly varying

colors. When young, they are usually light brown in color, but when ripe they become grayish-silvery white. Different varieties of canes varied as to the stiffness of the arrows; arrangement of flowers in the arrow; length, size, and color of fresh stalk of arrow; and habits of flowering. C. A. C. 87 had the strongest arrow and strong wind did not break it. Badila had rather brittle arrows, but owing to the large size of the stalks, it resisted moderate wind without being broken. Negros Purple had brittle arrows, also. Very few arrows of this cane could be seen with their terminal portions. The explanation of this is that a slight breeze or the alighting of a bird on the inflorescence would cause the arrow to break. In arrangement of flowers, those of Badila and Negros Purple were arranged in a more compact manner than those of C. A. C. 87. The arrows of these two varieties were larger

Fig. 1.—(*a*) Appearance of arrow of Negros Purple before flowers begin to open. (*b*) Appearance of arrow of C. A. C. 87 before flowers begin to open. (*c*) Appearance of arrow of Badila before flowers begin to open.

and longer than those of C. A. C. 87. Badila had the largest arrow, Negros Purple next, and C. A. C. 87, the smallest. After the emergence of the tip of the arrow, each variety exhibited different characteristics. In the case of Badila the arrow protruded about half its full length before the flowers began to open. The opening of flowers with C. A. C. 87 took place in a fewer number of days than with Badila. Negros Purple sent about two thirds of the full length of the arrow out and spread in the air before pollination commenced, the arrow thus remained for several days without opening. In some arrows of Negros Purple, the flowers began to open after all portions of the arrows had been exposed. Figure 1 shows the relative protrusion of the arrows before pollination or opening of flowers began.

In the flowering season (1924-1925) none of the arrows of ratoon Badila developed fully, so not a single seed was obtained. From Louisiana, United States, it was reported that only two arrows developed in the first ratoon. Under Los Baños conditions the ratoon cane of Badila arrowed less than the plant cane; few stalks flowered, and few arrows developed. Negros Purple did not arrow at all.

Opening of flowers. The greater number of sugar cane flowers opened in the morning, the time varying with the variety. The flowers of C. A. C. 87, representing the thin canes, opened very early in the morning, while those of Badila of the thick type opened late.

Table 3 gives the date and time when the cane flowers actually opened. On rainy days, most of the flowers opened in the morning, but the opening continued the whole day. With Badila, the beginning of opening was slightly different, that is, the flowers opened on sunny days at 6:10 a.m. and on cloudy and rainy days about a half hour later. The flowers of C. A. C. 87 began opening earlier than 5:30 a. m. every day, and on cloudy and rainy days most of them opened by 6:10 and 6:20. Negros Purple opened most of its flowers by 6:15 a. m. on sunny days, and by 6:40 on cloudy and rainy days.

The length of time of opening of flowers varied, not only with varieties, but also with individuals (see table 4). With Badila, the average length of time of opening was 13.7 minutes, with C. A. C. 87, 17.5 minutes, and with Negros Purple, 23.1 minutes.

As shown in table 5, a healthy arrow of Badila had an average of 89.95 per cent of open flowers; of C. A. C. 87, 96.2 per cent; and of Negros Purple, 24.3 per cent. This table shows that C. A. C. 87 had the largest number of open flowers, Badila next, and Negros Purple the lowest. Some flowers were found to be imperfect, that is no ovaries bearing stigmas were found and only the palea and glumes were present. These imperfect flowers were found at the bases and tips of the spikelets. In the case of Badila, some of the flowers remained closed, most of the spikelets died, thus giving to parts of the arrow a whitish appearance.

Observations were made on the length of time the stigmas remained fresh. A number of flowers of each variety was studied. Through a hand lens, just after the flowers opened, the fresh stigmas could be seen to have a "syrupy secretion which serves to hold whatever pollen grains might fall upon them." After the flowers opened, the stigmas spread their purplish feather-like structures ready for pollination. After a time, the stigmas lost the sticky secretion, causing their receptive power to cease.

Duration of pollination. Under normal conditions, rise in temperature causes anthers to dehisce. The discharge of pollen grains was found to vary according to variety. C. A. C. 87 discharged its pollen grains as early as 6:05 in the morning, and Badila a half hour and Negros Purple an hour later.

As shown in table 6, the pollination of sugar cane usually took place in the morning, except on rainy days when the discharge of pollen grains lasted the whole day. On cloudy days the pollination occurred rather late. In all cases the anthers dehisced mostly in the morning, and only a few flowers opened during a whole day when it was raining. With Badila, pollination began at 6:30 a. m., and most anthers discharged their pollen grains between 6:48 and 7:35 a. m. The discharge of pollen grains of C. A.C. 87 commenced as early as 6:05 a. m. on sunny days and as late as 8:35 on cloudy days. Of the three varieties studied, it was found that Negros Purple discharged its pollen grains the latest and nearly all the syrupy secretion of the stigma had dried out before the anthers opened. Pollination commenced at 7:15 a. m. on sunny days and lasted to 7:50, hence there was less chance for the early opening flowers to be fertilized.

Dissemination of pollen grains. The opened flowers of the three varieties studied attracted insects to visit them. It was observed that the presence of insects indicate the opening of anthers. It was found during the course of pollination that bees and other insects began humming about the flowers as the anthers opened. As more anthers dehisced, more insects came. As soon as pollination ceased the bees began leaving the flowers. When the flowers opened during the whole day, insects were constant visitors to the flowers. *Apis indica* Fabr. (Apidae; Hymenoptera) was the most common flower visitor. *Praustista moesta* Westwood (Fulgoridæ; Homoptera), which is one of the most harmful leaf insects of the sugar cane was occasionally caught among the flowers.

Owing to the minuteness of the pollen grains, they can be carried easily by the wind and insects. Table 7 gives the number of pollen grains found at various distances from the mother plant. It was found that more pollen grains were transported when the wind velocity was great. On November 23, 1924, the pollen catchers were rained on, hence the record obtained was not at normal condition. With an average wind velocity of 20.4 miles an hour, on an area of 15.39 square millimeters, at a distance of one meter from the mother plant, 46 fertile and 22 sterile pollen grains were caught; at a distance of two meters, 25 fertile and 13 sterile; at three meters, 16 fertile and 10 sterile; at four meters, 10 fertile and 11 sterile; and at five meters, 8 fertile and 11 sterile.

Comparative percentage of flowering stalks. It was found that different varieties of canes had different flowering power. In some varieties almost all the stalks flowered, in others few, still others did not flower at all.

As shown in table 8, 25.2 per cent of the millable stalks of Badila flowered, 85.3 per cent of C. A. C. 87, and only 34.8 per cent of Negros Purple.

Difference between "early" and "late" arrows. As to time of flowering, it was found that arrows were divided into two main groups; namely, the "late" and the "early". The early arrows generally developed normally.

They had more flowers than the late ones. They were healthier, larger, and emerged freely from the last leaf sheath if undisturbed by such things as hard wind, heavy rain, and severe cuts on the stalks. The late arrows were smaller and had fewer flowers than the early ones. The whole inflorescence of the late group did not come out freely. Most of the flowers remained in the sheath without being exposed to the air.

In the 1925-1926 flowering season during which this study was made, the second arrowing period took place in the middle of December. With Badila, out of twenty-four late arrows found, only three had the half portions out; the other portions remained hidden. With C. A. C. 87, eight late arrows had all the half portions out. In Negros Purple many of the late arrows did not come out at all. The non-development of the late arrows might have been due to one or more of four causes; namely, (*a*) The plant food absorbed by the roots was utilized for the development of nodal shoots. (*b*) A case of rotting was found. According to Dr. G. O. Ocfemia, of the Department of Plant Pathology, the symptoms of the rot were much like those of the gumming disease of sugar cane. (*c*) The cause of the late arrows might have been incomplete development. (*d*) The climatic conditions may not have been favorable.

Laboratory observations

Number of flowers per arrow. As shown in table 9 the number of flowers to the arrow varied according to variety. Badila had an average of 41,839 flowers to the arrow; C. A. C. 87, 24,260; and Negros Purple, 41,740. In the three varieties studied, there was an average of 35,946.36 flowers to the arrow.

Pollen grains. As shown in table 10, the approximate number of pollen grains per anther, per flower, and per arrow varied. Badila, as found on the College Farm, had an average of from 1,749 to 1,919 pollen grains per anther; C. A. C. 87, from 1,793.3 to 2,748; and Negros Purple, 1,326. The average number of pollen grains per flower was 5,503.8 with Badila; 6,811.9 with C. A. C. 87; and 3,978 with Negros Purple. An arrow of Badila had an average of 230,273,488 pollen grains; C. A. C. 87, 165,256,-694; and Negros Purple, 166,041,720, the general average of the three being 187,190,634. From these data it is clearly seen that C. A. C. 87 had the greatest number of pollen grains to the flower, Badila next, and Negros Purple the least. From these results, the belief may be entertained that C. A. C. 87 had more chances for effective pollination than either of the other two varieties, consequently more seeds could be expected.

There were two kinds of pollen grains found; namely, the fertile, or normal, and the sterile, or abnornal. The number of fertile and sterile pollen grains varied according to variety. As shown in table 11, Badila had 39.9 per cent of fertile pollen grains and 60.1 per cent of sterile; C. A. C. 87, 50.2 per cent of fertile and 49.8 per cent of sterile; and Negros Purple,

25.8 per cent of fertile and 74.2 per cent of sterile. There was an average of 38.6 per cent of fertile pollen grains and 61.4 per cent of the sterile for the three varieties.

After the pollination period, as shown in table 12, it was found that in each fresh stigma, Badila had an average of 20 pollen grains to a stigma; C. A. C. 87, 28; and Negros Purple, 19.

Of the several germination media used, the stigma of the sugar cane was found to be the best. Also it was the most readily secured during the flowering period and could be handled easily under the microscope. As shown in table 13, the pollen grains did not remain viable longer than seven hours. They began to germinate within an hour. Not all the pollen grains germinated. The germination obtained was 52.27 per cent with Badila, 39.1 per cent with C. A. C. 87, and 34.9 per cent with Negros Purple. The way the grains were dropped upon the stigmas may have had something to do with germination of the mature pollen grains. For when they fell upon the axis of the stigmas no germination took place.

Of the two methods used in preserving pollen grains, the second proved to be the more satisfactory, requiring less care than the first method. Roots were found growing from the root band of the lower portion of the stalk. The crate of double layer of banana bracts was opened in the afternoon of November 30 and it was found that the arrow protruded fully. The anthers were yellowish white in color. Those at the tip were opened but most of the others were found closed. By this time all the flowers of C. A. C. 87 had passed the pollination period of the early arrows, so no pollen grains of the same variety could be secured to cross with the arrow of P. B. 119. The following morning all the anthers were opened and the pollen grains had been discharged from their respective anthers. The temperature in the crate remained constant at 23° C. during the course of the experiment. In this method it was found that it was necessary to keep the arrow in as dry a condition as possible, even a drop of moisture wrapped in it would cause the rotting of the whole arrow.

Pollen grains, as well as anthers and stigmas, varied in size, shape, and color. This is shown in table 14. The fertile pollen grains were yellowish in color while the sterile ones were whitish yellow. The pollen grains that were measured, represented only the fertile ones. The average diameter of stained pollen grains of Badila was 0.0485 millimeter; of C. A. C. 87, 0.0477 millimeter; of Negros Purple, 0.0455 millimeter. It was found that the pollen grains of Badila and C. A. C. 87 had a more uniform diameter than those of Negros Purple.

Anthers varied also in size according to varieties. The anthers of Badila had an average length of 1.949 millimeters and a breadth of 0.450 millimeter; C. A. C. 87 had a length of 1.795 millimeters and a breadth of 0.626 millimeter, and Negros Purple a length of 1.572 millimeters and a breadth of 0.489 millimeter. In obtaining these measurements, fresh

anthers were used. From these figures, it is evident that Negros Purple had the shortest anthers and Badila the longest.

The stigmas of Badila had an average length of 1.999 millimeters; C. A. C. 87 of 1.980 millimeters; and Negros Purple of 1.596 millimeters. Badila had the longest stigmas and Negros Purple, the shortest. As shown in table 16, bagged arrows gave a lower percentage of germination than the unbagged. C. A. C. 87 bagged arrows gave only 55 seedlings, while with Negros Purple no germination was obtained. The bagging was found to have an adverse influence on the seeding of the enclosed arrow, owing to the rather unnatural conditions inside the bag. The temperature inside the bag, as shown in table 15, was higher than that outside and ants and spiders built their homes inside the bag.

Cultures

Preservation of cane stalks in solutions. Different solutions, so far as observed, had different effects in preserving cane stalks. Some solutions favored the growth of the roots while others did not.

In tap water containing powdered charcoal, the cane stalks kept only four days or less without wilting. The leaves began to turn yellow two days after placing the stalks in the solution.

Sulfurous acid was found to keep the cane stalks with leaves fresh from ten to sixteen days. Roots developed well, but died afterward.

Normal salt mixtures gave a better result than the ordinary tap water. They kept the stalks with leaves fresh from five to seven days. The leaves then wilted. If the stalks were allowed to remain in the solution they recovered and grew for over two months. At the end of that time, it was found that the old leaves were still green and many roots developed. The shoots or young leaves, however, were found to be dry. Although the stalks sent out shoots, it was observed that the arrows did not develop normally in this solution.

It was found that one per cent of ammonium hydroxide was detrimental to the growth of the canes. The stalks turned black and the solution yellowish. No roots were produced.

One per cent ammonium phosphate solution kept the stalks fresh from six to seventeen days which was longer than with water alone. At first the leaves wilted and the tips of the leaves dried, but they recovered after a few days. Roots developed well in the solution.

One per cent sulfuric acid diluted to from 5 to 100 parts with water was found to keep the cane stalks longer than water alone. In some cases, roots developed but they dried later.

Diluted one per cent acetic acid kept the stalks and leaves fresh for eight days but did not induce development of the roots.

The leaves of cane stalks in one per cent hydrochloric acid remained fresh from seven to twelve days. Roots developed, arrows protruded fully, flowers opened, anthers dehisced, but no seeds were found.

Chlorine water diluted to from 10 to 20 parts with water kept cane stalks the longest, from eight to thirty days. Roots developed well, shoots grew, arrows protruded freely, but no seed was obtained.

Ammonium sulfate, ferric citrate, and sodium chloride gave poor results.

Collection of tassels. It was found that all arrows collected at the mature stage gave a higher percentage of germination than when collected when immature. No molds were found among the flowers collected.

Planting the seeds in seed boxes. The best results were observed if the fuzz was spread uniformly and thinly on the surface of fine soil. The fuzz that was kept wet for three or four days gave the best and most uniform start of germination. It was found that failure to obtain the greatest number of seedlings might be due to several causes; namely, (*a*) the fuzz was planted too thickly; (*b*) it was not watered uniformly; (*c*) all the flowers did not develop normally; (*d*) the fuzz was too old; (*e*) the cover of the seed box was not satisfactory.

Germination of the seeds. The materials and method used in planting the seeds this year were so good that they may be recommended. It was found that seeds planted immediately gave the best percentage of germination. Seeds from different varieties of sugar cane used differed in vitality. In some varieties, the fuzz, although the seeds were planted when mature, did not produce seedlings at all. That few or no seeds developed during the course of pollination accounts for this result.

In the varieties studied, C. A. C. 87, Negros Purple, and Badila, seeds from ratoon and plant canes gave practically the same number of seedlings. The number of seedlings produced to the arrow depended upon the vigor of the individual stalks. Evidence of germination was found from the seventh day after planting. Germination lasted from four to five days, depending upon the age of the fuzz and the way the seeds were sown.

It may be seen in table 16 that arrows from different treatment had varying germinating capacity. Of the three varieties studied, it was found that C. A. C. 87 gave the greatest number of seedlings to the arrow. Badila arrows were longer, larger, and had more flowers than C. A. C. 87, but some of the spikelets did not develop fully, consequently, fewer seeds were produced than from C. A. C. 87. From Negros Purple the highest number of seedlings obtained from one arrow was only twenty, as few seeds developed. The probable explanation of this low number is that during the course of opening of flowers and dehiscence of anthers the stigmas remained open for half an hour or so before the discharge of pollen grains took place. Hence, the syrupy secretion of the stigmas was dried.

It was found that the length of time from shooting to ripening of seeds varied according to variety. The seeds of C. A. C. 87 ripened in from 22 to 24 days. Negros Purple produced seedlings in from 18 to 22 days. Badila seeds were ready for planting in from 30 to 47 days from shooting to cutting of the arrows. Seedlings grew vigorously in compost soil. The seedlings in the ordinary soil were stunted and the leaves, yellowish.

SUMMARY

1. The sugar cane varieties used in this study varied in the age at which they flowered, from 289 to 428 days.

2. The emergence of the whole arrow took place in from eight to eleven days and pollination began in about three to seven days after shooting.

3. Opening of the flowers began about 5:30 a. m. or earlier, almost all being opened before 7:00 a. m. On rainy days few flowers opened, but the course of opening lasted the whole day.

4. Dehiscence of anthers began about an hour after the opening of flowers. Pollination is effective only during the period of dehiscence.

5. During the pollination period insects were found about the flowers. Their presence was a sure sign that anthers had begun opening.

6. Pollen grains, as well as anthers and stigmas, varied in size. C. A. C. 87 was more fully supplied with pollen grains than Badila or Negros Purple.

7. Of the solutions tried, chlorine water diluted with 10 to 20 parts of water, and sulfurous acid diluted with 20 to 40 parts were found to keep cane stalks with leaves fresh for two weeks or more. Normal salt mixture appeared to be promising for this purpose, for although the leaves wilted in from 2 to 3 days, they recovered, roots developed, and the leaves remained fresh over a month. In slightly acid solution, the stalks remained fresh and green. These three solutions served as good media for the study of the root development of the sugar cane plant.

8. The best medium found for germinating pollen grains was the fresh stigmas of the sugar cane, as they can be handled easily under the microscope. The pollen grains were found to decrease in viability after two or three hours.

9. Anthers can be kept close for twelve days or more and their pollen grains can be used for pollination work.

10. For the three varieties, Badila, C. A. C. 87, and Negros Purple, there was an average of 35,946.36 flowers per arrow; 107,839.08 anthers per arrow; and 187,190,634 pollen grains per arrow.

11. Flowers of sugar cane are largely pollinated by wind, insects act as a lesser agent. Of the three varieties studied, C. A. C. 87 had the greatest number of flowering stalks, Badila, next, and Negros Purple, the least.

12. Of the three varieties, Negros Purple produced the fewest seedlings. Some arrows gave no seedlings at all. The non-development of seeds in this variety is explained by the fact that only the late opening flowers had the chance of being pollinated, as the early opening ones had passed their female receptive period before the male elements came out.

13. The bagging process was found to be an unsafe and unreliable method of selfing a variety of cane. The results so far obtained indicated that preservation of cane stalks in solution would probably replace the bagging operation in the future in selfing.

14. Should it be desired to cross two of these varieties of canes, it is recommended that C. A. C. 87 be used as "father" as it is better supplied with pollen grains than the others and dehiscence of anthers occurs early. Badila or Negros Purple may be used as "mother" for the stigmas of each are ready for pollination by the time C. A. C. 87 anthers begin to dehisce.

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TABLE 1

Relative date and age of flowering

VARIETY USED	DATE			AGE	DATE OF SECOND FLOWERING
	Planted	Cut to ratoon	Of First flowering		
		1925	1925	*days*	1925
Badila (ratoon)		January 29	November 16	291	December 18
Badila (plant cane)	September 24, 1924		November 16	428	December 18
Badila (plant cane)	January 31, 1925		November 16	289	December 20
C. A. C. 87 (ratoon)		January 17	November 4	291	December 12
C. A. C. 87 (plant cane)	January 1, 1925		November 6	309	December 15
Negros Purple (plant cane)	October 24, 1924		October 27	368	December 20

TABLE 2

Average length of time from the appearance of the tip of the arrow to full emergence, pollination, and ripening of seeds

VARIETY NAME	PLANT CANE				RATOON			
	Length of time from shooting to				Length of time from shooting			
	Full emergence of arrow	Pollination	Most flowers open	Ripening of seeds	Full emergence of arrow	Pollination	Most flowers open	Ripening of seeds
	days	*days*	*days*	*days*	*days*	*days*	*days*	*days*
Badila	10.2	4.7	7.1	23.7	10.2	5.0	9.0	23.5
C. A. C. 87	11.1	4.2	9.9	22.6	11.0	3.5	2.5	22.0
Negros Purple	8.5	7.1	12.5	20.9				

TABLE 3

Date and time of opening of flowers

DATE OF OBSERVATION	TIME FLOWERS			CONDITION OF THE DAY
	Began to open	Mostly opened	Time of closing	
1925	*a. m.*	*a. m.*		
Badila (plant cane)				
November 26	6:45	7:40	9:50 a. m.	Cloudy morning
November 27	6:45	7:40	9:55 a. m.	Cloudy morning
November 28	6:50	7:50	5:30 p. m.	Rainy day
November 29	6:30	7:40	9:45 a. m.	Cloudy day
November 30	6:10	7:10	8:00 a. m.	Sunny day
December 1	6:15	7:10	8:00 a. m.	Sunny day
December 3	6:25	7:50	5:30 p. m.	Cloudy morning and rainy afternoon
C. A. C. 87 (plant cane)				
November 17	*Earlier than* 5:30	6:20	5:30 p. m.	Rainy day
November 18	5:30	6:20	5:30 p. m.	Rainy day
November 19	5:30	6:10	8:00 a. m.	Sunny day
November 20	5:30	6:10	8:00 a. m.	Sunny day
November 21	5:30	6:10	8:30 a. m.	Cloudy day
November 22	5:30	6:15	5:30 p. m.	Rainy day
November 23	5:30	6:15	5:30 p. m.	Rainy day
Negros Purple (plant cane)				
November 7	*Earlier than* 5:45	6:45	8:25 a. m.	Cloudy day
November 9	5:35	6:50	5:30 p. m.	Rainy day
November 10	5:30	5:50	5:30 p. m.	Rainy day
November 12	5:30	6:30	8:20 a. m.	Cloudy day
November 14	5:30	6:30	8:15 a. m.	Cloudy day
November 15	5:30	6:15	8:10 a. m.	Sunny day
November 16	5:30	6:30	8:15 a. m.	Cloudy day
November 23	5:30	6:45	5:30 p. m.	Rainy day

TABLE 4

Duration of opening of flowers

VARIETY NAME	NUMBER OF MINUTES
Badila	13.7
C. A. C. 87	17.5
Negros Purple	23.1

TABLE 5

Comparative production of open flowers [a]

VARIETY NAME	PERCENTAGE OF OPEN FLOWERS
Badila (ratoon)	90.60
Badila (plant cane)	89.30
Average	89.95
C. A. C. 87 (ratoon)	96.40
C. A. C. 87 (plant cane)	96.00
Average	96.20
Negros Purple (plant cane)	24.30

[a] Observation was made on healthy arrows.

TABLE 6

Comparative date and time of dehiscence of anthers

DATE OF OBSERVATION	TIME ANTHERS		TERMINATION OF DEHISCENCE	WEATHER OF THE DAY
	Began to dehisce	Mostly dehisced		
1925	*a. m.*	*a. m.*		
Badila (plant cane)				
November 24	6:45	7:35	9:30 a. m.	Cloudy day
November 27	6:43	7:30	9:30 a. m.	Cloudy day
November 28	6.30	7:30	9:30 a. m.	Cloudy day
November 29	6:55	7:20	9:20 a. m.	Cloudy day
November 30	6:35	6:48	7:30 a. m.	Sunny day
December 1	6:36	7:15	7:50 a. m.	Sunny day
December 3	6:36	7:05	5:30 p. m.	Rainy day
December 4	6:36	7:04	5:30 p. m.	Rainy day
C. A. C. 87 (plant cane)				
November 17	6:25	6:47	5:30 p. m.	Rainy day
November 18	6:25	6:49	5:30 p. m.	Rainy day
November 19	6:18	6:28	8:15 a. m.	Sunny day
November 20	6:17	6:29	8:15 a. m.	Sunny day
November 21	6:18	6:29	8:35 a. m.	Cloudy day
November 22	6:17	6:30	5:30 p. m.	Rainy day
November 23	6:18	6:30	8:30 a. m.	Cloudy day
November 24	6:05	6:25	8:30 a. m.	Cloudy day
Negros Purple (plant cane)				
November 21	7:30	7:45	8:40	Cloudy day
November 24	7:30	7:45	8:30	Cloudy day
November 29	7:45	7:50	8:40	Cloudy day
November 30	7:15	7:35	8:20	Sunny day
December 1	7:15	7:50	8:40	Cloudy day

TABLE 7

Pollen grains caught near the cane plant

DATE	ONE METER FROM THE PARENT PLANT		TWO METERS FROM THE PARENT PLANT		THREE METERS FROM THE PARENT PLANT		FOUR METERS FROM THE PARENT PLANT		FIVE METERS FROM THE PARENT PLANT		VELOCITY OF THE WIND [a]
	Fertile	Sterile	Fertile	Sterile	Fertile	Sterile	Fertile	Sterile	Fertile	Sterile	Miles per hour
November 21, 1924	63	12	50	15	33	13	22	6	15	8	33.2
November 23, 1924	28	11	17	8	11	9	6	14	8	17	24.3[b]
November 21, 1925	49	43	9	18	5	8	3	13	2	8	3.9
Average.....	46.6	22.0	25.3	13.6	16.3	10	10.3	11	8.3	11	20.4

[a] Data from the Department of Plant Physiology.

[b] The pollen catchers on this date were rained on.

TABLE 8

Percentage of flowering stalks of the three varieties

VARIETY NAME	NUMBER OF MILLABLE		PERCENTAGE OF MILLABLE FLOWERING STALKS
	Stalks	Flowering stalks	
Badila (ratoon)	60	12	20.0
Badila (plant cane)	184	56	30.4
Average	122	34	25.2
C. A. C. 87 (ratoon)	142	124	87.3
C. A. C. 87 (plant cane)	104	87	83.3
Average	123	106.5	85.3
Negros Purple (plant cane)	215	75	34.8

TABLE 9

Average number of flowers per arrow

	BADILA		C. A. C. 87		NEGROS PURPLE
	Ratoon	Plant cane	Ratoon	Plant cane	Plant cane
Average number of flowers per arrow	36,896.4	46,782	22,515.3	26,005.8	41,740.1
Average number of flowers per arrow in one variety	41,839.0		24,260.0		41,740.1
Average number of flowers per arrow for the three varieties.	35,946.36				

TABLE 10

Approximate number of pollen grains per anther, per flower, and per arrow

	BADILA				C. A. C. 87				NEGROS PURPLE	
	Ratoon		Plant cane		Ratoon		Plant cane		Plant cane	
	Fertile	Sterile	Fertile	Sterile	Fertile	Sterile	Fertile	Sterile	Fertile	Sterile
Average number of pollen grains per anther	815.7	1,103.7	652.9	1,096.9	843	950.3	1,438	1,310	273	1,053
Total number of pollen grains per anther	1,919.4		1,749.8		1,793.3		2,748		1,326	
Number of pollen grains per flower	5,758.2		5,249.4		5,379.9		8,244		3,978	
Number of pollen grains per flower in each variety	5,503.8				6,811.9				3,978	
Average number of pollen grains per arrow in each variety	230,273,488				165,256,694				166,041,720	
Average number of pollen grains per arrow for the three varieties	187,190,634									

TABLE 11

Kinds of pollen grains produced per anther

VARIETY NAME	AVERAGE NUMBER OF FERTILE POLLEN GRAINS	AVERAGE NUMBER OF STERILE POLLEN GRAINS	TOTAL NUMBER OF POLLEN GRAINS	PERCENTAGE OF FERTILE POLLEN GRAINS	PERCENTAGE OF STERILE POLLEN GRAINS
Badila	734.3	1,110.3	1,832.6	39.9	60.1
C. A. C. 87	1,140.5	1,130.1	2,270.6	50.2	49.8
Negros Purple	273.0	1,053.0	1,326.0	25.8	74.2
Average	715.9	1,097.8	1,809.7	38.6	61.3

TABLE 12

Relative abundance of pollen grains found in one fresh stigma

	BADILA		C. A. C. 87		NEGROS PURPLE
	Ratoon	Plant cane	Ratoon	Plant cane	Plant cane
	21	20	24	33	19
Average	20		28		19

TABLE 13

Germination of pollen grains

VARIETY NAME	PERCENTAGE
Badila	52.27
C. A. C. 87	39.10
Negros Purple	34.90

TABLE 14

Average size of pollen grain, anther, and stigma

VARIETY NAME	SIZE			
	Pollen grain	Anther		Stigma
	Diameter	Length	Diameter	Length
	mm.	*mm.*	*mm.*	*mm.*
Badila	0.0485	1.949	0.450	1.999
C. A. C. 87	0.0477	1.795	0.626	1.980
Negros Purple	0.0455	1.572	0.489	1.596

TABLE 15

Temperature inside and outside the bag
Negros Purple

DATE	MORNING		NOON		AFTERNOON		REMARKS
	Degrees Centigrade		Degrees Centigrade		Degrees Centigrade		
	Inside	Outside	Inside	Outside	Inside	Outside	
1925							
November 7	25.9	25.9	30.0	28.5	25.4	25.1	Sunny day
November 8	21.7	21.5	31.0	30.3	28.5	27.3	Sunny day
November 9	21.7	21.3	30.1	29.0	25.3	24.5	Cloudy day
November 10	24.5	23.7					Rainy day (No other record was taken)
November 11	28.7	27.9	28.3	27.8	31.6	30.3	Cloudy day
November 14	24.5	24.0	31.5	30.6	57.5	26.8	Cloudy day
November 15	24.8	24.0	32.0	31.3	26.5	26.0	Cloudy day
November 16	24.5	24.0	36.0	35.3	25.0	24.4	Cloudy day
November 17	24.5	23.9	30.0	29.4	25.0	24.5	Cloudy day
November 18	24.5	24.0	28.8	28.1	25.0	24.4	Rainy day
November 19	24.3	24.0	28.6	27.8	26.0	25.3	Sunny day
November 20	25.7	25.0	31.0	30.0	28.0	27.3	Sunny day
November 22	26.0	25.2	30.0	29.0	25.0	24.4	Cloudy day
November 23	26.2	25.4					(No other record was taken)
			C. A. C. 87				
November 17	23.0	22.4	28.5	28.0	25.0	24.6	Cloudy day
November 19	24.5	24.0	30.1	28.6	26.0	24.5	Sunny day
November 20	24.3	23.8	30.1	27.9	25.0	24.6	Sunny day
November 21	23.8	23.8	31.0	30.1	28.0	27.3	Cloudy day
November 22	24.2	23.6	30.2	29.5	24.8	24.0	Cloudy day
November 23	24.2	24.3	28.4	27.6	25.0	24.2	Rainy day
November 24	25.2	24.6	29.8	28.2	28.0	27.5	Cloudy day
November 25	25.0	24.5	29.8	28.3	27.0	26.5	Cloudy day

TABLE 16

Germination of cane seeds

VARIETY NAME	RATOON OR PLANT CANE	NUMBER OF ARROW USED	AGE OF EMERGENCE TO		NUMBER OF SEEDLINGS FOUND	REMARKS
			Cutting of the arrow	Planting of the arrow		
			days	*days*		
Badila	Ratoon	1			65	From erect stalk
Badila	Ratoon	1	37	45	23	From erect stalk
Badila	Ratoon	1	40	40	26	From erect stalk
Badila	Ratoon	1	33	42	43	From bent stalk
Badila	Ratoon	1	47	46	7	From erect stalk
Badila	Plant cane	1			26	From erect stalk
Badila	Plant cane	1			1	From erect stalk
Badila	Plant cane	1	37	45	17	From erect stalk
Badila	Plant cane	1	30	45	33	From erect stalk
Badila	Plant cane	1	39	51	8	From erect stalk
Badila	Plant cane	1	40	53	85	From erect stalk
Badila	Plant cane	1	28	43	31	From erect stalk
Badila	Plant cane	1	26	46	2	From erect stalk
C. A. C. 87	Plant cane	1	24	33	37	From bent stalk
C. A. C. 87	Plant cane	1	23	32	55	From bent stalk, Hill I, bagged arrow
C. A. C. 87	Plant cane	1	22	32	75	From bent stalk, Hill I
C. A. C. 87	Plant cane	1	22	32	58	From bent stalk, Hill I
C. A. C. 87	Plant cane	1			68	From bent stalk, Hill II
C. A. C. 87	Plant cane	1			105	From bent stalk, Hill II
C. A. C. 87	Ratoon	1	18	31	55	From bent stalk, Hill I
C. A. C. 87	Ratoon	1	38	37	26	From erect stalk
Negros Purple	Plant cane	1	18	29	51	
Negros Purple	Plant cane	1	22	33	1	From erect stalk
Negros Purple	Plant cane	1	19	30	1	From erect stalk
Negros Purple	Plant cane	1	22	33	3	The arrow was healthy
Negros Purple	Plant cane	1	31	36	5	From erect stalk
					20	From erect stalk

COPRA MEAL VS. DRIED SHRIMPS AS SUPPLEMENTS TO A BASAL RATION CONSISTING OF CORN AND RICE BRAN FOR GROWING BARROWS[1]

MOISES S. SANTIAGO

WITH TWO TEXT FIGURES AND ONE CHART

Information concerning the relative value of supplemental feeds available in the Philippines on the rate and economy of gains of pigs is inadequate. Information such as this is essential to the foundation of the Philippine swine industry and is to be obtained only by experimenting on the local feeds with our own hogs. Work along this line is necessary in order to give a basis for the formulation of rations for those who are contemplating starting hog raising as a business.

The object of this experiment was to determine the relative value of copra meal and dried shrimps as supplements to a basal rations consisting of corn and rice bran for growing barrows.

Kole (1919) reported on the feeding of shrimps and starfish meal to pigs and poultry in Wageningen, Holland. He gave the following composition of the shrimps:

TABLE 1

Composition of shrimps

SHRIMPS	ALBUMIN	FAT	ASH AS CO_3
	per cent	*per cent*	*per cent*
Whole	66.0	8.1	20.7
Flesh	85.2	5.7	10.0
Shells	51.6	8.5	33.8

Kole did not, however, give the nutritive and economic value of shrimps for pigs.

So far, very little work concerning the feeding of shrimps to hogs has been carried out in the Philippines. Lago (1924) conducted an experiment in the College of Agriculture in which shrimps were used as a supplement to corn, rice bran, and copra meal in the self-feeding and self-choice system. He found that it required 415 kilograms of feed to produce 100 kilograms gain. With the same system of feeding, corn alone with dried shrimps as supplement, 365.7 kilograms of feed were required to produce 100 kilograms

[1] Thesis presented for graduation, 1925, with the degree of Bachelor of Agriculture from the College of Agriculture No. 230; Experiment Station contribution No. 379. Prepared in the Department of Animal Husbandry under the direction of Dr. Mariano Mondoñedo.

gain. In connection with this experiment, Lago also studied the effect of self-feeding and hand-feeding of corn, rice bran, and copra meal without shrimps. It required 400 kilograms of feed to produce 100 kilograms gain in the case of the hand-fed lot; and 453 kilograms feed to produce 100 kilograms gain in the self-fed lot.

Peña (1924) found that feeding a herd of Berkshire-Native pigs on sweet potato pasture with corn, rice bran, and copra meal in varying proportions, required an average of 508 kilograms of feed to produce 100 kilograms of pork.

Cavillero's (1925) results in his study on the effect of different mineral mixtures on growing gilts fed with a ration of five parts corn, seven parts rice bran, and three parts copra meal showed that it required an average of 650.99 kilograms of concentrates to produce 100 kilograms gain.

The experiment discussed in this paper was conducted in the Department of Animal Husbandry, College of Agriculture, Los Baños. It covered a period of 140 days, from June 16 to November 3, 1923.

MATERIALS AND METHODS

The animals

All the animals used in this experiment were raised by the Department of Animal Husbandry and received the same treatment from birth. They were three-quarters and seven-eighths Berkshire-Native barrows from three litters.

These barrows were weighed for three consecutive days beginning June 15, 1923, and the initial weight was taken from the average of these weights. The allotment, based upon such factors as age, weight, breeding, conformation, and thrift of each individual was made carefully. All pigs were in good condition at the beginning of the experiment.

Feeds used

The feeds used were shelled Native Yellow Flint corn, rice bran, copra meal, and dried shrimps for concentrates; ground charcoal and common salt for mineral mixture; and camote vines for roughage. A small part of the corn used was College product and the greater part was bought in Calamba at ₱5.00 a cavan (58.5 kilograms), or 8.55 centavos a kilogram. Rice bran was bought in Cabuyao, a town in the province of Laguna, for ₱1.55 a cavan (26 kilograms), or 5.96 centavos a kilogram. Copra meal was bought from The Manila Oil Company at ₱35.00 a ton, or 3.5 centavos a kilogram. The dried shrimps used were fresh water shrimps belonging to the species *Palaemon lanceifrons* Dana[2]. There were traces of various kinds of small snails and small fish known as goby, the species being *Glossobins giurus*,

[2] Identified by Dr. Albert W. Herre, Chief of the Division of Fisheries, Bureau of Science, P. I., June 4, 1924.

mixed with the shrimps. They were caught and dried unsalted by fishermen and bought by the College of Agriculture at ₱3.00 a cavan (12.5 kilograms), or 24 centavos a kilogram. Corn cob charcoal and common salt were used as mineral supplement. Camote vines (*Ipomœa batatas* Linn.) grown around the hog pen was used for roughage. Table 2 shows the average chemical composition of the feeds used.

TABLE 2

Percentage composition of feeds [a]

FEEDS	MOISTURE	ASH	PROTEIN (N×6.25)	CRUDE FIBER	NITROGEN FREE-EXTRACT	FAT
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Corn	13.88	2.61	8.90	2.86	67.28	4.47
Rice bran	13.81	15.48	11.56	14.27	36.47	8.41
Copra meal	12.83	7.26	17.50	15.73	40.91	5.77
Shrimps (dried)	14.55	19.73	55.61	4.24	3.26	2.61
Sweet potato vines	85.42	1.70	2.76	3.50	6.48	0.14

[a] Analyzed by the Department of Chemistry.

The experiment

The study was made on twelve pigs, which were divided into two lots of six pigs each. One lot was fed with a mixture of corn, rice bran, and copra meal. The other lot was fed with corn, rice bran, and dried shrimps. Both lots received the same mineral mixture consisting of equal parts charcoal and common salt. They were fed twice daily—early in the morning and late in the afternoon. Between meals, plenty of fresh water was provided. Roughage was given in the form of soilage.

The lots occupied two adjoining pens with adjoining yards in the hog house. Grass growing in the pens gave additional roughage, and the grazing gave exercise. The pigs were kept in these pens the greater part of the time. There were two or three occasions, each not lasting more than three days, when the pigs were turned out of their pens to camote pasture for purposes of disinfection and accommodating other pigs in the pens, temporarily.

Weekly weighings were made every Saturday afternoon.

EXPERIMENTS AND RESULTS

Plan of the experiment

The experiment was divided into two parts. The first part was begun June 16, 1923, and closed August 25, 1923, covering a period of ten weeks. The second part was begun on August 25, 1923, and closed November 3, 1923, covering a period of ten weeks also. In the first part of the experiment, lot I was given a concentrate ration consisting of corn, rice bran, and dried shrimps. Lot II was given a concentrate ration of corn, rice bran, and copra meal.

The rations were prepared weekly. The rations for both lots were kept in separate barrels. The mixture in each barrel was weighed at the beginning and at the end of each week. By subtracting the weight of the remaining mixture from its original weight, the weight of the feed consumed was found. Any portion left at the end of each week was added to the mixture the succeeding week.

Feeding

Henry-Morrison's (1922) feeding standard was used in computing the nutritive ratios of the feeds. The feeds used to make up one ration were in such proportions as to have, approximately, the same nutritive ratio as that of

Fig. 1.—Lot I pigs after being fed the shrimp mixture for 70 days.

the other ration. During the first five weeks of the first part of the experiment, lot I was given 6 parts corn, 13 parts rice bran, and 1 part dried shrimps, and lot II was given 6 parts corn, 13 parts rice bran, and 11 parts copra meal, both of which have a nutritive ratio of 1:5.4. From the sixth week up to the end of the experiment the proportion was changed to make a wider nutritive ratio as needed by the growing pigs. Lot I then was given 6 parts corn, 13 parts rice bran, and 0.9 part dried shrimps with a nutritive ratio of 1:5.5. Lot II was given 6 parts corn, 13 parts rice bran, and 9 parts copra meal, having a nutritive ratio of 1:5.7.

In the second part of the experiment the ration for the two lots was reversed. The lot that was getting shrimps in the first part of the experiment was given copra meal for supplement in the second part. During the first five weeks, lot I was then given 6 parts corn, 13 parts rice bran, and 6 parts copra meal with a nutritive ratio of 1:5.8, and lot II was given a ration of 6 parts corn, 13 parts rice bran, and 0.8 part dried shrimps with a nutritive ratio of 1:5.6. During the last five weeks, lot I received a ration of 6 parts corn, 13 parts rice bran, and 4 parts copra meal having a nutritive ratio of 1:6.1, and lot II received a ration of 6 parts corn, 13 parts rice bran, and 0.5 part dried shrimps, having a nutritive ratio of 1:5.8.

Fig. 2.—Lot II pigs after being fed the copra meal mixture for 70 days.

Both lots were hand-fed throughout. The rations were fed in the form of thick slop. The pigs were given such amount of feed as they would easily consume. In feeding, they were given their ration in small quantities until they were satisfied. This was done so as to prevent their choosing certain feeds in the mixture.

Enough clean fresh water was given after each meal to last the pigs until the next feeding time.

Observations

First part of the experiment. About a week after the experiment was started, one of the things which struck the attention of the writer was the evident unpalatability of the ration containing copra meal. The animals

in the copra meal lot were not eating their ration with relish, as did the animals in the shrimp lot. Lot II consumed less amount of feed during the first week than that consumed by the animals in lot I during the same period. The unpalatability of this ration was further confirmed by the fact that the amount of feeds consumed weekly throughout the experiment showed practically no increase. The shrimps ration was evidently more palatable than the copra meal ration as shown by the animals' eagerness to eat and by their greater and steadier increase throughout the experiment.

The animals in lot II very frequently experienced labored defecation; and the feces were dry and hard in consistency, showing that they suffered from constipation, while the animals of lot I had normal soft feces. Some kernels of corn were undigested in the feces of the animals in both lots. The feces were examined for intestinal parasites at the end of the experiment. According to the report of the findings from the College of Veterinary Science, the barrows in lot II (copra meal lot) showed heavier infestations with intestinal parasites than those of lot I (shrimp lot). The following is the report:

Lot I. Shrimp lot
Barrow H. N. 303—Ascaris, heavy
Barrow H. N. 306—Negative
Barrow H. N. 307—Negative
Barrow H. N. 316—Oesophagostoma, moderate
Barrow H. N. 322—Ascaris and Oesophagostoma, light
Barrow H. N. 324—Negative

Lot II. Copra meal lot
Barrow H. N. 305—Ascaris, light
Barrow H. N. 308—Ascaris, light
Barrow H. N. 315—Ascaris, Oesophagostoma, and Trichuris, heavy
Barrow H. N. 321—Ascaris and Oesophagostoma, light
Barrow H. N. 323—Ascaris, moderate
Barrow H. N. 325—Ascaris, heavy; Oesophagostoma, light

Photographs of the animals were taken at the end of the first part of the experiment. Lot I animals were round, fat, and low set (fig. 1). One of the barrows (305) in lot II was sick at the end of the experiment and died two weeks later of chronic inflammation of the digestive system due to intestinal parasites. This animal was not included in lot II of the second part of the experiment. The exclusion of this pig in this lot was the cause for the break in the graph of the weight curve (see chart 1, plotted on arith-log grid).

Second part of the experiment. The animals in lot I showed a tendency to constipation and no longer relished their feed as they did when fed with shrimps. They could not consume as much feed as they did during the first part nor did they increase in weight and size as fast as they did at first. The animals in lot II showed eagerness to eat in marked contrast to their lack of appetite when fed the copra meal ration. They consumed more feed weekly than those of lot I. The animals grew faster than they

TABLE 3

Summary of results

	PART I		PART II	
	Lot I Corn..... 6 parts Rice bran.....13 parts Dried shrimps. 0.9–1.0 N. R. 1:5.4–5.5	Lot II Corn..... 6 parts Rice bran.....13 parts Copra meal..9–11 parts N. R. 1:5.4–5.7	Lot I Corn..... 6 parts Rice bran....13 parts Copra meal..4–6 parts N. R. 1:5.84–6.09	Lot II Corn..... 6 parts Rice bran.....13 parts Dried shrimps..0.6–0.8 N. R. 1:5.63–5.8
Number of pigs	6	6	6	5
Duration of experiment	70 days	70 days	70 days	70 days
Total initial weight	76.0 kgm.	75.6 kgm.	188.6 kgm.	93.7 kgm.
Average initial weight	12.7 kgm.	12.6 kgm.	31.4 kgm.	18.7 kgm.
Total final weight	188.6 kgm.	104.1 kgm.	260.0 kgm.	167.5 kgm.
Average final weight	31.4 kgm.	17.4 kgm.	43.3 kgm.	33.5 kgm.
Total gain	112.6 kgm.	28.5 kgm.	71.4 kgm.	73.8 kgm.
Average gain	18.7 kgm.	4.75 kgm.	11.9 kgm.	14.8 kgm.
Average daily gain per pig	0.267 kgm.	0.068 kgm.	0.17 kgm.	0.21 kgm.
Grain consumed:				
Corn	159.81 kgm.	59.31 kgm.	144.52 kgm.	142.39 kgm.
Rice bran	346.25 kgm.	128.51 kgm.	313.13 kgm.	308.52 kgm.
Copra meal	———	98.17 kgm.	118.35 kgm.	———
Dried shrimps	24.95 kgm.	———	———	16.08 kgm.
Total grain feed consumed	531.0 kgm.	285.99 kgm.	576.0 kgm.	466.99 kgm.
Cost of grain consumed:				
Corn	₱13.66	₱ 5.08	₱12.35	₱12.17
Rice bran	₱20.64	₱ 7.66	₱18.67	₱18.41
Copra meal	———	₱ 3.44	₱ 4.14	———
Dried shrimps	₱ 5.99	———	———	₱ 3.86
Total cost of grain consumed	₱40.29	₱16.18	₱35.16	₱34.44
Average daily grain per pig	1.26 kgm.	0.68 kgm.	1.37 kgm.	1.33 kgm.
Grain feed consumed per kgm. gain	4.71 kgm.	10.03 kgm.	8.07 kgm.	6.32 kgm.
Cost of grain to produce 1 kgm. gain	₱ 0.36	₱ 0.57	₱ 0.49	₱ 0.47
Grain feed consumed per 100 kgm. gain	471.4 kgm.	1003.00 kgm.	806.7 kgm.	632.00 kgm.
Cost of grain to produce 100 kgm. gain	₱35.78	₱56.75	₱49.24	₱46.67

did in the first part and were free from constipation. Though they were not as good looking animals as those in lot I, their rate of gain increased more when fed with the shrimp mixture than when fed with the copra meal mixture.

Results

As a result of the experiment, as may be seen in table 3 and in the graph, the two lots when fed with corn, rice bran, and dried shrimps showed better results than when fed with corn, rice bran, and copra meal. In the first part of the experiment, lot I consumed 531 kilograms of grain and gained 112.6 kilograms, thus requiring 4.714 kilograms grain to a kilogram gain. Lot II consumed 286 kilograms and gained 28.5 kilograms, thus requiring 10.03 kilograms grain to a kilogram gain.

In the second part of the experiment, lot I consumed 576 kilograms of feed and gained 71.4 kilograms, thus requiring 8.067 kilograms grain to produce one kilogram of pork liye weight. Lot II consumed 467 kilograms of feed and gained 73.8 kilograms, thus requiring 6.32 kilograms grain to produce one kilogram gain. Therefore, in both cases, in the first and second parts of the experiment, the animals fed with the ration containing dried shrimps required less feed to produce a kilogram gain than those fed with ration containing copra meal.

The cost of producing one kilogram gain in lot I of the first part of the experiment was ₱0.36 and in lot II was ₱0.57. In the second part of the experiment, the cost of producing one kilogram gain in lot I was ₱0.49 and in lot II, ₱0.47.

The average daily gain per pig in lot I in the first part of the experiment was 0.267 kilogram and in lot II, 0.068 kilogram. In the second part of the experiment, lot I had an average daily gain per pig of 0.17 kilogram while lot II gained 0.21 kilogram.

DISCUSSION OF RESULTS

First part of the experiment

Gains in weight. It may be seen in table 3 that lot I gained 112.6 kilograms, while lot II gained only 28.5 kilograms. The question arises as to how the gains were made and what were the underlying cause or causes. The greater gain made by lot I may be traced from two sources; (*a*) the increase in the animals' capacity to consume more feeds; and (*b*) increase in their ability to make more pork out of their rations. Lot I consumed 531 kilograms of grain and gained 112.6 kilograms. Lot II consumed 286 kilograms grain and gained 28.5 kilograms. From these figures, it may be noted that lot II was able to consume only a little more than half (53.86 per cent) as much as lot I. If the greater gain made by lot I was due only to the increase in the pigs' capacity to consume more feeds, which in this case is double that of the consumption of lot II, the gain, other things being

equal, should have been about double that made by lot II, or about 57 kilograms. Lot I, however, actually gained four times the gain made by lot II. So it is natural to conclude that lot I was able to increase not only in ability to consume more grain but also to make more pork out of their ration. While it is not known to what this increase in the feeding ability of lot I was due, it is reasonable to infer that something must have been supplied by the shrimps to directly or indirectly influence not only the capacity of the animals in lot I to ingest more feed but also to digest and assimilate a much greater percentage of the feed given them than was possible for the pigs in lot II, on copra meal.

Comparing the chemical analysis of the copra meal and dried shrimp (see table 2) it may be seen that dried shrimp has a narrower nutritive ratio than copra meal and hence is a better supplement.

The shrimps, being of animal nature, are likely to possess in greater proportion than copra meal the properties favorable to growth commonly attributed to feeds of animal origin—such as nutrients, accessory food factors, etc. Chemical analysis of shrimp and of copra meal shows that the former contains a greater proportion of protein and ash than the latter. These two properties are much looked for in a supplement, particularly for growing pigs.

The shrimps proved to be much more palatable than copra meal, and added to the palatability of the other feeds mixed with them to make up the ration. The greater consumption of the shrimp mixture than of the copra meal mixture is evidence of the difference in palatability. The pigs in lot I were very vigorous feeders and consumed a greater amount of their ration than did those of lot II, within the same length of time of feeding. The lot I pigs were never off feed throughout the experiment. On the other hand, the pigs in lot II were listless, coming tardily to the trough at feeding time, approaching it walking instead of running as with lot I. The amount of 25 kilograms of feeds consumed in the last week was almost the same as that of the first week (28 kilograms). Lot I, on the other hand, consumed 30 kilograms of grain during the first week and 77 during the last week of the experiment.

The shrimps seemed to have a stimulating effect on the digestive system of the pigs. The animals in lot I never showed signs of constipation; the movement of the bowels and the consistency of the feces were regular and normal. The animals in lot II, on the other hand, were off feed every time they showed signs of constipation, which was quite frequently and at irregular intervals. As all factors other than the two kinds of supplements under study were made as equal as possible for the two lots, the conclusion is that the constipating property must be in the copra meal. This depressing effect on the digestive system must necessarily retard growth. Derecho (1921)) found that copra meal is constipating for guinea pigs. Sulit (1926) found that when copra meal forms 75 to 85 per cent of the ration, it is toxic and deleterious to guinea pigs and albino rats. He gave 37 per

cent copra meal in a ration as about the quantity promotive of better health, vigor, and normal reproduction both of guinea pigs and albino rats. In this experiment copra meal formed about 34.4 per cent of the ration and constipation was already noted.

Economy of gain. Table 3 shows that lot I had an average daily gain of 0.267 kilogram and consumed 4.714 kilograms to produce a kilogram of live weight pork. Lot II had an average daily gain of 0.068 kilogram and consumed 10.03 kilograms of grain per kilogram pork. It is very clearly shown that the shrimp ration is not only more economical than copra meal ration in the sense that it can produce more pork per kilogram grain but also in the sense that it can increase the rate of growth of the animals. The faster the animals grow, the better it is for the feeder, because it lowers the cost of housing, keeping, feeding, and management, and the risks from injury, disease, and death are proportionately lessened. It cost in feeds, ₱0.36 to produce a kilogram of pork in lot I, and ₱0.57 in lot II. It is of importance to note that although the shrimps cost about seven times as much as the copra meal, it costs less and takes less feed to produce pork with shrimps as supplement than with copra meal.

At the close of the experiment, microscopic examination of the feces of the pigs was made and lot II was found to be much more heavily infested with intestinal parasites than lot I. As both lots were exposed to the same surroundings and were often together in the same inclosure, except at feeding time, lot II was more susceptible to infestation than lot I. It is generally believed that parasites and disease producing organisms thrive better on a poorly nourished host than on a well fed one, because the natural defenses are weakened.

Second part of the experiment

The lots of pigs used in the second part of the experiment were the same lots that were used in the first part. Only the rations given were reversed, that is, lot I received copra meal mixture and lot II, shrimp mixture It may be noted in table 3 that in the average daily gain, total grain feed consumed, average daily grain consumed per pig, the average grain consumed per kilogram gain, and the cost of grain per kilogram gain, there is a complete reversal of results in favor of lot II. The greater gain made in lot II was very likely due to the same factors that gave such good results in lot I in the first part of the experiment. The results obtained in favor of lot II in the second part of the experiment, however, were not so great as in lot I in the first part of the experiment, owing to the fact that the pigs in lot I were in very good condition at the beginning of the second part, while the pigs in lot II were comparatively smaller and more spare in condition.

It will be remembered that lot II during the first part of the experiment when the copra meal mixture was fed, made a gain of only 28.5 kilogram. It is to be expected that the pigs as they grow up will make a greater amount

of gain than when they are young. But the change in the amount of gain from 28.5 kilograms during the first seventy-day period to 73.8 kilograms for the next seventy-day period is more than can be expected had they remained on the same ration used in the first part of the experiment. The graph of the weights (see chart 1) made by lot II in the first two periods shows that there was a very marked steady rise of the growth curve during the second part of the experiment. As there was no change made in the care and management of the pigs, other than a change in the ration, it is logical to conclude that the shrimps were responsible for the acceleration in the gaining power of the pigs.

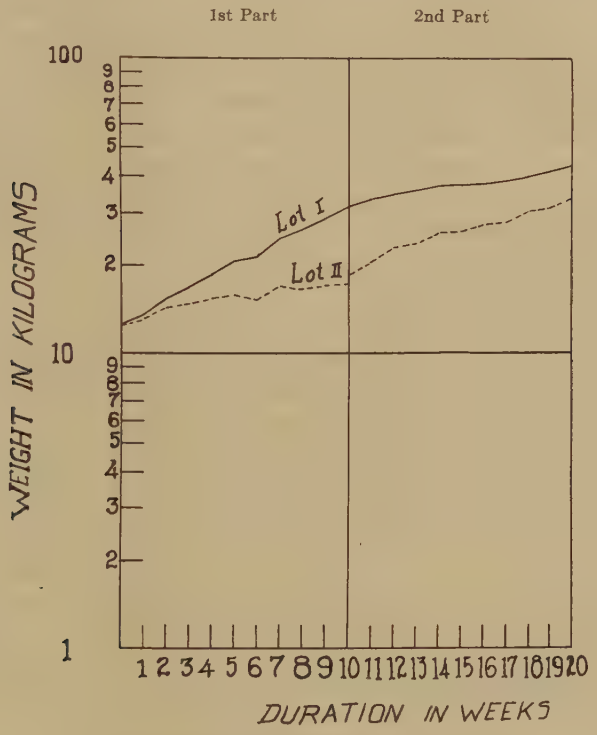

Chart 1.—Comparisons of the weights of lot I and lot II.

Lot I, on the other hand, while it made a gain of 112.6 kilograms during the first seventy-day period made a gain of only 71.4 kilograms the second period, a result not to be expected had the pigs in this lot been allowed to continue receiving the feed given during the first part of the experiment. As it was, there was a very decided decrease in their ability to make gains during the second part of the experiment. The chart shows clearly this drop in the curve of lot I during the second half of the experiment. The decline actually began during the first week of the second part of the experiment coincident with the first marked rise in the gain made by lot II. This

change in the behavior of the growth curves for the two lots is also coincident with the reversal of the rations.

The average daily gain per pig of lot I during the first part was 0.267 kilogram and in the second part, 0.17 kilogram, showing a decrease of 0.097 kilogram. Lot II made an average daily gain per pig of 0.07 kilogram during the first part of the experiment and 0.21 kilogram in the second part, showing an increase average daily gain of 0.14 kilogram. It will be noted that the decrease of lot I during the second part is not so great as the increase in the average daily gain of lot II during the same period. This comparatively small decrease in the average of lot I is largely due to the fact that the pigs were in very good condition at the beginning of the second part of the experiment and the change from a rather good ration to a poor one was not so greatly felt, especially when it is taken into account that the pigs were older and larger and the amount of the copra meal in the ration is much less than that received by lot II during the first part of the experiment. With regard to lot II, which was practically on a maintenance ration during the first part, the relatively large increase in the average daily gain made by them in this part of the experiment points out the good effect of changing the ration from a poor one to a good one—in this case from a copra meal mixture to a shrimp mixture.

It is also very interesting to note the changes in the consumption of feed made by the two lots from the first to the second parts of the experiment. The total shrimp mixture consumed by lot I during the first part was 531 kilograms and the copra meal mixture during the second part, 576 kilograms, a relatively insignificant increase of nine per cent in the amount of feeds consumed. Lot II on the other hand showed a change of consumption from 286 kilograms of the copra meal mixture during the first part to 467 kilograms of the shrimp mixture during the second part of the experiment, an increase of 63 per cent.

Finally it may also be noted in table 3 that when lot I was getting the shrimp mixture it took only 4.71 kilograms of feed to make a kilogram gain, but when the pigs were made to subsist on the copra meal mixture during the second part of the experiment, 8.067 kilograms of the ration were required to make a kilogram gain. Lot II, when receiving the copra meal mixture during the first part, required 10.03 kilograms of the ration to make one kilogram gain, and 6.32 kilograms of the ration when receiving the shrimp mixture during the second part.

With the relatively smaller amount of the shrimp mixture required to produce a kilogram gain, there followed, also, the relatively less cost to produce it. In the first part of the experiment it took ₱0.36 worth of the shrimp mixture to produce one kilogram gain in lot I, and in the second part, ₱0.49 worth of the copra meal mixture. In lot II it took ₱0.57 worth of the copra meal mixture to produce one kilogram gain and only ₱0.47 worth of the shrimp mixture.

An objection may be raised to the use of shrimp for this purpose because of its cost being seven times more than copra meal, but when the rapid gains made on it are taken into account, shrimp may be fed with profit even at this price, as was shown by results in this experiment.

SUMMARY OF CONCLUSIONS

1. Copra meal, when used as a supplement to corn and rice bran in the proportion of corn, six parts; rice bran, thirteen parts; and copra meal from nine to eleven parts, did not stimulate the rate of growth of barrows. The pigs made slow gains. It had a constipating effect on the pigs even when each lot was supplied from two to four kilograms of camote vines daily.

2. Shrimps as supplement to corn and rice bran, may be fed to growing pigs with very good results.

3. When shrimps are fed with corn and rice bran in the proportion of six parts corn, thirteen parts rice bran, and from six-tenths to one part of dried shrimps, the rate of growth of the barrows was greatly increased.

4. The cost of producing a kilogram gain may be reduced by using shrimps instead of copra meal to supplement corn and rice bran.

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THE MANUFACTURE AND CHEMICAL CONTROL OF SOME SOYBEAN PRODUCTS UNDER LOS BAÑOS CONDITIONS[1]

LEOPOLDO G. SALAZAR

WITH TWO TEXT FIGURES

Soybean is botanically known as *Glycine hispida* Maxim. and is also called soya or soja bean, and *pak tau* (Chinese). It is an important nitrogenous food, and a crop of prime importance in some countries where rice is the principal article of the diet. The Chinese and Japanese manufacture a large variety of food products from the soybean, among which may be mentioned soy sauce or *toyo*, bean curd or *tokua*, soybean milk, flour, salad oils, butter, and lard substitutes.

Of these products, the sauce and the curd are the most important. To Americans the sauce is known as *soy sauce*, to the Japanese as *shoyu*, to the Chinese as *ch'au yau*, or drawing oil; to the Filipinos as *toyo*. The curd, cake, or cheese is known as *teou-fu* and *tao-hu* in China; *tofu* in Japan; and *tokua* in the Philippines. Soybean cheese is a misnomer, as the product is obtained without any ripening process.

Toyo is commonly used as a condiment by Japanese and Chinese of all classes. And in their dietaries tokua and other soybean products take the place of meat and other nitrogenous animal foods (Piper and Morse, 1923). There is a common saying in some parts of China that "soybean milk is the poor man's milk and the soybean curd, the poor man's meat" (Adolph and Kiang, 1921). In Japan alone the annual production of toyo amounts to considerably over 2,000,000 barrels, the per capita consumption being estimated to be about 2.5 ounces daily (Piper and Morse, 1923). Besides being a very good source of proteins, toyo and tokua contain also the requisite amounts of mineral constituents which are essential for growth (Adolph and Kiang, 1921).

The increasingly large quantities of toyo exported annually from China, Japan, and Hawaii to American and European countries show that the use of this product is becoming more and more universal.

In the Philippines, the use of toyo and tokua is becoming more and more general, so that a knowledge of their preparation should be of value.

[1] Thesis presented for graduation, 1925, with the degree of Bachelor of Agriculture from the College of Agriculture, No. 231; Experiment Station contribution No. 380. Prepared in the Department of Agricultural Chemistry under the direction of Dr. Manuel L. Roxas and Professor Felipe T. Adriano. Revised for publication by Dr. F. O. Santos.

REVIEW OF LITERATURE

The book by Piper and Morse (1921) is the most comprehensive treatise on the soybean. Besides dealing extensively with the cultural methods, it gives descriptions of methods, manufacture, and analyses of the different industrial products. A list of its varied uses is also included.

Langworthy (1899) gave analyses of the different varieties of the soybean and some of its products and described a method of preparing the curd.

Rurhrah (1911) described the methods of preparing gruels, broths, muffins, nut-cakes, cakes, breakfast food, pancakes, cheese, and bread from soybean flour.

Linder (1912) gave the analysis of tokua which was submitted to him from the market, as follows: protein, 42.19 per cent; fat, 6.92; and ash, 2.2. The tokua prepared in his laboratory gave consistently higher results: protein, 59.46 per cent; fat, 11.86; and ash, 5.19. In the course of a few trials, he found that tokua must be consumed within a few days as it deteriorates rapidly on standing.

Groff (1919) described in detail the method of manufacturing soy sauce in Kwangtung, China, and illustrated the process by a system of multiple drawings.

Adolph and Kiang (1921) reviewed the history and uses of the soybean and some of its products and indicated the important relationships which these food products bear in the Chinese dietary. They also gave analyses of the bean, the curd, the milk, and some of the by-products obtained in their manufacture.

Thom and Church (1921) found that the soy process in Japan is based on the diastatic action of *Aspergillus oryzæ* on the soybean.

Church (1923) of the United States Department of Agriculture worked on the Japanese method of preparing the sauce and on the relation of enzymatic activity to the soy process and other related fermentations. Miss Church also experimented on the possibility of using peanut press cake for making a sauce similar to shoyu.

A comparison of the chemical analyses of some of the bean products obtained by different investigators is given in table 1. Whenever an investigator reported more than one analysis for one kind of product, the average of two or more analyses was calculated. With the analysis of the soybean milk is given the analysis of cow's milk, to show the comparative nutritive value of these two foods.

In the Philippines, only three investigations, those of Gibbs and Agcaoili (1912), Gibbs, Agcaoili, and Shilling (1912), and Barrett (1911) have so far been reported. In addition to the analyses of some of the local products as purchased in the Manila markets, these three papers give descriptions of the methods of manufacture followed by the Chinese.

TABLE 1

mical composition of some soybean products reported by different investigators

					SAUCE			SOYBEAN MILK AND COW'S MILK				TAHULI OR TAHURI *a*		BEAN RESIDUE OR SAPAL
923)	Linder (1912)		Langworthy (1899))		Gibbs & Agcaoili (1912)		Piper and Morse (1923)	Langworthy (1899)		Adolph & Kiang (1921)		Gibbs & Agcaoili (1912)		Adolph and Kiang (1921)
Fried	From market *d*	Prepared in lab.*d*	Fresh	Frozen	Toyo	Toyo made with sugar *e*	Shoyu *f*	Soybean *g*	Cow's	Soybean *h*	Cow's	Solid	Liquid	Sapal *i*
per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
57.40	———	———	89.15	17.70	65.26	58.31	61.46	92.53	86.08	93.00	87.00	55.76	57.86	85.18
21.96	42.19	59.46	4.94	48.50	0.75	4.93	8.68	3.02	4.00	3.45	3.30	14.56	9.56	4.15
18.72	6.92	11.86	3.40	28.50	———	———		2.13	3.05	1.59	4.00	7.12	2.09	2.01
0.57			3.23	2.60	———	———		1.88	5.09	1.64	5.00			5.88
1.37	2.20	5.19	0.49	1.70	27.47	24.74	19.11	0.41	0.70	0.33	0.70			0.68
					2.59	9.50								
					3.25	———								
					28.86	20.12	20.55							
					———	Trace								
					0.68	2.52						12.70	16.38	

ıple.
cose, 3.80 per cent; dextrin, 0.98 per cent.
$_5$, 0.47 per cent; sp. gr. 1.203.

g Fiber, 0.03.
h Salted and preserved soy beans.
i Residue after obtaining soybean milk. Fiber, 2.68 per cent.

Showing a comparison of the che

CONSTITUENTS	BEAN CURD								
	Block *a*		Geerlings *b*	Konig *c*	Gibbs and Agcaoili (1912)	Adolph & Kiang (1921)	Piper and Morse (1		
	Cheese	Pressed cakes	Tao-hu	Tofu	Baked cakes, tokua	Bean curd	Fresh tofu	Frozen tofu	
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	
Water	83.75	88.75	76.15	84.81	72.55	81.87	88.12	18.72	
Proteins	11.25	———	13.15	7.41	15.72	10.11	6.06	48.65	
Fats	4.33	0.04	7.09	5.25	10.89	3.67	3.36	28.65	
Carbohydrates (N. F. E.)	———					3.42	2.89	2.33	
Ash	0.57	0.36	2.21	1.08	1.24	0.95	0.54	1.65	
Reducing sugars (as invert)									
Sucrose									
Sodium chloride									
Alcohol									
Undetermined, probably fat									

a, b, c Cited by Gibbs and Agcaoili, 1912.

d Analyses based on moisture free san
e Acidity as acetic, 1.68 per cent; glu
f Acidity as lactic, 1.06 per cent; P_2O

OBJECTS OF THE PRESENT WORK

The objects of this work were: (*a*) to determine the possibility of preparing toyo and tokua under Los Baños conditions; and (*b*) to determine the time at which the toyo contains the highest percentage of nitrogen.

TIME AND PLACE OF PRESENT WORK

This work was performed in the laboratory of the Department of Agricultural Chemistry, University of the Philippines, Los Baños, Laguna, from April, 1924, to February, 1925.

MATERIALS AND METHODS

The yellow variety of soybean obtained from a Chinese store in Manila was used in this experiment. An analysis performed by the Chemistry

Fig. 1.—Some apparatus and materials used in the preparation of toyo: (*1*) pure cultures of *Aspergillu* in potato agar; (*2*) glazed earthenware jars with covers; (*3*) *sanduk*, a native coconut shell spoon; (*4*) *balañga*, a native large clay jar; (*5*) wire sieves used in the fermentation of the mixtures of soybeans and wheat flour.

Department Food Laboratory shows that these beans had the following proximate composition: moisture, 9.2 per cent; ether-extract (crude fats), 16.87 per cent; ash, 4.75 per cent; protein, 21.27 per cent; crude fiber, 7.05 per cent; carbohydrates (nitrogen-free-extract), 40.84 per cent.

The *batong sungsong*[2], the coagulating agent used in the preparation of tokua was obtained from a Chinese tokua factory in Manila.

The yellowish-green strain of *Aspergillus*, the organism used in the experiment, was obtained by the fermentation of a mixture of boiled soybean and wheat flour in the dark room. After obtaining this yellowish-green strain of *Aspergillus*, it was cultured in potato agar. The pure cultures so

[2] Analysis performed by the Chemistry Department Experiment Station Laboratory shows that it is mostly calcium sulfate (gypsum).

obtained were used in inoculating the mixtures of boiled soybeans and wheat flour preparatory to the fermentation.

The other materials used were: large wire sieves, glazed earthenware jars, table salt, *balañga* (Tag.) a large clay jar, boiling pans, native millstone, *sinamay* cloth, cheese cloth, tincture press and chemical apparatus.

The method employed in the preparation of the toyo was one of several used by the Chinese in Manila. The writer made special trips to some of the toyo and tokua factories and obtained information on the subject.

EXPERIMENTS

Preparation of toyo

In a *balañga* 3472 grams of soybeans were boiled until soft to the touch. The boiled beans were then placed in a wire sieve for about fifteen minutes to drain off as much of the water as possible. The drained beans were divided into four equal parts and each part was thoroughly mixed with 1268 grams of wheat flour. The proportion of soybean, wheat flour, and salt used in the experiment was adopted from Sawer [3]. Each mixture was placed in a wire sieve and inoculated with the culture of *Aspergillus*. The inoculated mixtures were then placed on racks in a dark corner of a room, which was open on only one side to allow some circulation of the air. The mixtures were kept in this room for eight days. The fungus in the early stages of development was yellowish-green in color and turned brown after the lapse of from four to five days. The growth of a black mold could not be prevented even after careful inoculation. However, before the mold could produce spores, the colonies were carefully picked from the mass of beans leaving only the desirable organism to ripen. On the seventh day, the mixtures were totally covered with the fungus the spores of which were fully developed, and the whole had completely changed to a brown mass. The almost solidified portion of each of the four masses was placed in a glazed earthenware jar. To each of the four jars (I, II, III, and IV) brine water (1565.5 grams table salt dissolved in 4113 cc. of rain water) was added. The mixtures were exposed to the sun from September 4 to December 11, 1924, and allowed to ferment in the open, taking care that they were always covered during the night and on rainy days, to prevent any addition of rain water.

Bi-weekly determination of total, albuminoid, and amido nitrogen during the process of fermentation was made. The methods adopted by the Association of Official Agricultural Chemists (1920) for the determination of the above constituents were followed. Bi-weekly samplings of the toyo were made by first stirring the whole mass and filtering a sample of the liquid through filter paper. Analyses were then performed on the filtrates obtained.

[3] *Cited by* Piper and Morse (1923).

On December 8, 1924, three days before the first drawing off of the toyo, the fermented mass was diluted with enough rain water to restore the original volume, as during the fermentation a considerable portion of the liquid evaporates. On December 11, 1924, the whole mass was filtered off through cheese cloth. The filtrate of jar I was boiled until salts began to crystallize on the surface of the liquid. During the boiling the scum formed was occasionally removed with a *sanduk*, a native coconut shell spoon. The boiled sauce was allowed to stand for two days until all of the solids settled at the bottom, and then was slowly decanted into another jar. The toyo was then bottled and was ready for the table. The filtrate of jar II was sunned for one month, the common practice in the preparation of the high grade products. According to Groff (1919), the Chinese claim that the sauce obtained by sunning gives a better quality product and commands a higher price that that which is boiled. After one month's sunning, the toyo was bottled and ready for use.

Fig. 2.—Some apparatus used in the preparation of tokua: (*1*) tincture press; (*2*) native mill-stone; (*3*) *sanduk*, a native coconut shell spoon; (*4*) *sinamay* cloth; (*5*) boiling pan; (*6*) strainer.

Brine water (761.9 grams common salt dissolved in 3809.5 cc. of water) was added to the residue of each jar and allowed to ferment for another month. Three days before drawing off the toyo, it was diluted as before with enough rain water to restore the original volume. At the end of one month's sunning, the toyo was filtered through cheese cloth. The filtrates of the two samples were mixed and boiled for some time. The boiled sauce was allowed to stand for two days to allow the solids to settle. The clear liquid was then decanted. The decanted toyo was bottled, ready for use. In neither the boiled nor the sunned samples, was the toyo of the second drawing as brown as the toyo of the first. The first drawing was a thick brown liquid. According to Groff (1919), the residue, called *tahuse* by the Chinese, of the first drawing can be used as many as four times for the preparation of this sauce.

The residue and the toyo of the first drawing, before and after sunning, were analyzed for total albuminoid and amido nitrogen. The residue of the second drawing, the sunned and the boiled toyo of the first and second drawings, respectively, were analyzed for the proximate composition.

Preparation of tokua

The tokua was prepared by the method used by the Chinese in Manila. Three hundred grams of soybeans were soaked in clean water for five hours, after which time pronounced swelling had taken place. The soaking and consequent swelling of the beans facilitates the extraction of the bean proteins (Piper and Morse, 1923). The soaked beans were washed thoroughly and then ground in a native millstone. During the process of grinding, about one liter of water was from time to time added through the feed hole to facilitate the flow of the semi-liquid mass. The white creamy liquid which flowed from the millstone was poured into 500 cc. of boiling water and the mixture heated for one hour. During the boiling, 1000 cc. of water was added gradually from time to time, taking care not to disturb abruptly the boiling of the mass. The boiled mass while still very hot was strained through sinamay cloth. The residue, locally known as *sapal*, was washed thoroughly with 1000 cc. of hot water. The sinamay cloth containing the residue was pressed to expel as much of the remaining liquid as possible. To the hot filtrate, which is known as soybean milk, 35 grams of burned and powdered *batong sungsong* suspended in water were added gradually until a curd formed. The material was allowed to stand for half an hour, by which time complete coagulation of the curd should have taken place. The curd was strained through sinamay cloth. The strained curd was then placed in small square pieces of cheese cloth and pressed in a tincture press to expel as much of the water as possible. The cakes were allowed to remain in the press for about 30 minutes when the pressure was released and the compressed cakes were found to be just solid enough to stand handling. In this form, the cakes are put in the market as tokua.

The milk, residue, or *sapal* and tokua were analyzed for total, albuminoid, and amido nitrogen. The residue and tokua were analyzed for their proximate chemical composition.

The tokua so prepared cannot stand more than a day without deterioration, hence the cakes are soaked in brine solution for a time, then treated with burnt sugar or molasses, and finally baked slightly. The burnt sugar or molasses gives a uniform brown color, while baking hardens the cake on the outside without materially affecting the inside. After this treatment, the cakes may be kept for a week without spoiling.

RESULTS

The results are given in tables 2, 3, 4, 5, and 6.

Length of time required for preparation

Toyo. The time required for the different operations was: boiling of the beans, at least 24 hours; growth of the mold in the mixture of boiled and drained beans and wheat flour, 7 days; fermentation about 84 days for the first drawing. The filtrate of the first drawing was allowed to ferment in the sun for one month. The *tahuse*, or residue of the first drawing, was treated with brine water and then allowed to ferment for another month.

Tokua. The time required for the different operations was: soaking of the beans, 4 to 5 hours; grinding of 300 grams of the beans, about 10 to 15 minutes; boiling of the semi-liquid mass, about one hour; straining and washing, about 10 to 15 minutes; coagulation of the milk, about one-half hour; pressing of the curd 50 to 60 minutes; the total time required being about 8 hours.

Factors influencing success in the process

Toyo. Some of the points to be considered for the success in the preparation are: (*a*) Boiling the beans. They should be boiled until soft to the touch so that they may be readily available for the action of the organism. (*b*) Only *Aspergillus* organism should be used, as the presence of black molds and other undesirable organisms results in an inferior product, and in cases of serious contamination, the sauce may be totally unfit for human consumption. (*c*) The mixture of boiled beans and wheat flour must be thoroughly covered with the fungus growth before it is put in brine in glazed earthenware jars. (*d*) The right proportion of ingredients, boiled soybean, wheat flour, and brine solution, should be followed to obtain good results.

Tokua. Some points to be considered for the success of the manufacture of this product are: (*a*) Soaking the beans, which in effect prepares them for a better extraction of the proteins, should be continued not more than five hours unless running water is used, as a longer time results in a sour product. If not soaked in running water, the soaked beans should be thoroughly washed before grinding. (*b*) To obtain the maximum yield of the curd, the *galapong*, or creamy liquid which flows from the millstone, should be thoroughly boiled and treated with sufficient water during the boiling. (*c*) While still very hot, the milk should be treated with the requisite amount of coagulating agent until the curd begins to form. If the milk is allowed to cool, complete coagulation does not take place easily.

DISCUSSION OF RESULTS

The changes taking place during the different stages of fermentation, according to Nishimura[5], are due to the action of the powerful enzymes of *Aspergillus oryzæ* upon the carbohydrates of the soybean. Oshima[5] also found that the protein materials present in the soybean are also converted

[5] *Cited by* Piper and Morse (1923).

by the proteolytic ferments into a more soluble form than those originally present. The production of glucose also takes place; this is accounted for by the action of the diastase upon the carbohydrates. Alcohol can be detected in the early stages of the ripening process, but in the last stages part of the alcohol is converted into acid. As the fermentation is prolonged, the amount of acetic acid increases, because the alcohol, due to the action of the bacteria, is converted into the acid and other substances; these give the sauce its agreeable odor and flavor.

TABLE 2

Nitrogenous compounds of the toyo at different stages of fermentation

TIME OF SAMPLING	SPECIFIC GRAVITY AT ORDINARY TEMPERATURE	NITROGEN		
		Total	Albuminoid	Amido
		per cent	*per cent*	*per cent*
After 14 days	1.200	0.16	0.00	0.16
After 28 days	1.209	0.22	0.03	0.19
After 42 days	1.238	0.41	0.04	0.38
After 56 days	1.250	0.68	0.04	0.64
After 70 days	1.250	0.66	0.04	0.62
After 84 days	1.251	0.69	0.04	0.65
After 98 days	1.250	0.69	0.04	0.65

TABLE 3

Nitrogenous compounds of toyo and its by-products

SAMPLES	SPECIFIC GRAVITY AT ORDINARY TEMPERATURE	NITROGEN		
		Total	Albuminoid	Amido
		per cent	*per cent*	*per cent*
Toyo, first drawing	1.207	0.56	0.04	0.52
Toyo, first drawing boiled	1.272	0.96	0.03	0.93
Toyo, first drawing. After 1 month sunning	1.235	0.62	0.05	0.57
Toyo, second drawing, boiled	1.230	0.34	0.03	0.31
Residue, or *tahuse* of the first drawing		1.58	1.13	0.45
Residue, or *tahuse* of the second drawing		1.14	0.95	0.19

TABLE 4

Nitrogenous compounds of bean curd, or tokua and its by-products

SAMPLE	NITROGEN		
	Total	Albuminoid	Amido
	per cent	*per cent*	*per cent*
Residue, or *sapal*	1.02	1.01	0.01
Soybean milk[a]	0.30	0.18	0.12
Tokua	2.39	1.49	0.90

[a] The preparation of tokua requires that this stage of the process be diluted with sufficient water.

Table 2 shows that the increase of nitrogenous compounds in the toyo is more rapid in the earlier stages of the fermentation. After 84 days the amounts of the different nitrogenous compounds did not show any appreciable increase.

Table 3 gives the analysis of the nitrogenous compounds of the toyo and its by-products. The percentage of total and amido nitrogen of the boiled toyo is higher than that of the sunned sample while that of albuminoid in both cases remains about the same. Boiling reduces the volume of the product considerably and while the percentage of total nitrogen in the boiled toyo is greater than that of the product which is sunned, the amount of shrinkage in volume is correspondingly higher. The sunned toyo will give greater monetary returns for two reasons: (1) The product is sold on the basis of volume; (2) It commands a higher price on account of the flavor and odor which is only highly developed in toyo which is allowed to ferment in the sun.

The results of analysis of the *tahuse*, or residue after separating the toyo of the second drawing, showed that it contained 1.14 per cent total nitrogen. This is the reason *tahuse* can be used as many as four times for the preparation of toyo.

Table 4 shows the quantities of the nitrogenous compounds in the *sapal*, the milk, and the tokua. The amount of total nitrogen left in the *sapal* is 1.02 per cent. It is sold as a rich nitrogenous animal feed. The high protein content of tokua makes it also a very rich nitrogenous food. The composition of the milk reported in the table is low because it had been diluted with a large volume of water preparatory to the coagulation process.

Table 5 gives a comparison of the proximate composition of a sample of a superior grade of toyo obtained from Sengkee & Co. of Manila and of samples of toyo and tokua and their by-products prepared in the laboratory. The table shows that the sample of toyo prepared in the laboratory compared favorably with the superior grade product purchased in the market.

Table 6 gives the data on the experimental yield of tokua using a uniform sample of 300 grams each time. As may be seen, the yield is about 320 grams of tokua for every 300 grams of the bean. The extra weight is accounted for by the water absorbed and the amount of coagulating agent, mostly calcium sulfate (gypsum).

Experiments were run to determine the exact length of time necessary to ferment the moldy mixtures so as to give the sauce its maximum protein content. The results of the test are given in table 2 and indicate that the first drawing off of the sauce should be made at the end of 56 days fermentation, after this period the sauce was found to have no further increase in the protein content.

SUMMARY

1. Methods for the preparation of toyo and tokua under Los Baños conditions have been discussed.

2. After 8 weeks of fermentation the toyo was found to be ready for the first drawing.

3. Analyses showed that the toyo prepared in the laboratory compared favorably in composition, odor, and flavor with the superior grade product of the market.

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TABLE 5

Proximate composition of toyo and tokua and their by-products [a]

CONSTITUENTS	SUPERIOR TOYO FROM SENGKEE & CO.	TOYO FIRST DRAWING, BOILED	TOYO FIRST DRAWING, SUNNED	TOYO SECOND DRAWING, BOILED	TAHUSE SECOND DRAWING	TOKUA	SAPAL
Specific gravity	1.2342	1.2116	1.2349	1.2299			
Moisture	66.27	60.66	63.68	67.84	64.31	66.76	82.32
Crude fats (ether extract)	0.59	0.51	0.52	.23	8.63	5.97	1.94
Ash	21.12	20.75	19.68	24.11	13.78	7.30	0.62
Proteins (nitrogen × 6.25)	6.56	6.01	3.90	2.00	5.95	14.95	6.39
Crude fiber					1.95	2.99	4.72
Nitrogen free extract	7.46	12.07	12.22	5.82	5.33	2.03	4.01
Reducing sugars as dextrose	3.23	11.01	9.14	3.23			
Acidity (as acetic acid)	0.30	1.19	.83	0.44			
Sodium chloride	19.70	19.53	18.22	23.44			
Calorific value per 100 grams	62.97	78.87	70.93	34.20	48.39	125.14	60.68

[a] Determined by Experiment Station Food Laboratory of the Department of Agricultural Chemistry, U. P.

TABLE 6

Showing the experimental yield of tokua

	WEIGHT OF BEANS TAKEN	WEIGHT OF BATONG SUNG-SONG USED	WEIGHT OF TOKUA	WEIGHT OF SAPAL
	grams	*grams*	*grams*	*grams*
1	300	35	334	438
2	300	35	284	512.5
3	300	35	345	439.5
4	300	35	321.3	577.0
Average	300	35	321.1	492 0

A STUDY OF THE PORK SUPPLY IN THE CITY OF MANILA[1]

EULOGIO RODRIGUEZ, JR.

INTRODUCTION

Many hogs are brought to Manila for slaughter. Knowledge of the practices involved, the number and relation of the men engaged in the business of taking hogs from the producer to the consumer and the conditions affecting them is highly desirable.

The objects of the work reported in this paper were:

(1) To determine the source of hogs brought to the Manila markets and the conditions under which they are produced.

(2) To find out who are engaged in the production of pork and to determine the extent, development, and methods of management.

(3) To determine as far as possible: (*a*) The kind and number of middlemen; (*b*) The distribution of profits among the different classes of men engaged in the industry, such as the producer, middleman, butcher, vendor, etc., till the pork reaches the consumer.

(4) To determine the seasonal variation of the prices in pork and the causes thereof.

(5) To secure data on the following for one year, as representing the actual condition of the pork industry: (*a*) Origin of animals; (*b*) Methods of purchase and transportation; (*c*) Management of hogs before slaughter; (*d*) Number and weight of hogs butchered; (*e*) Distribution of dressed carcasses to the different markets of Manila; (*f*) Number of Filipinos, Chinese and other nationalities dealing in pork in the different markets of Manila.

The work was begun November, 1923, and ended October, 1924. Azcarraga slaughter-house, where all the kill of local animals for the Manila market is made, is the abattoir studied in this work. The markets studied are Divisoria, Quinta, Arranque, Paco, Obrero, Sampaloc, Tondo, and others.

Little has been written regarding the pork supply of Manila. Noguera (1918) made a study of the hog industry with special attention to the provinces around Manila during 1916-1918. He reported that the sources of pigs for the Manila market were Bataan, Pampanga, Bulacan, Rizal, Laguna, Batangas, Cavite, Tayabas, and the suburbs of Manila. He gave a general

[1] Special problem presented, 1924, in partial fulfillment of the requirements for the degree of Bachelor of Agriculture from the College of Agriculture. Experiment Station contribution No. 381. Prepared in the Department of Animal Husbandry under the direction of Dr. M. Mondoñedo.

idea of the characteristics of the native pig. As to the management, he gave the methods in common use and described the native method of castration and spaying. Among the common feeds he mentioned were: *Paliat* (copra meal), *puñgapong* (*Amorphophallus campanulatus*), cassava (*Manihot utilissima*), *kiapo* (*Pistia stratiotes*), rice bran, kitchen refuse, etc. He mentioned that there is always a good market for hogs in all parts of the Islands, both for local consumption and for shipment to larger towns and cities.

Manuel (1924) wrote on the meat supply of the city of Manila. In his study he corroborates the findings of Noguera, as to the source of hogs for the Manila market. He describes the methods used in purchasing pigs, the methods of slaughter, and the nationality of hog butchers and dealers.

The data herein presented for discussion were taken from the records available in the Market Division of the City of Manila, the Bureau of Agriculture, the Bureau of Customs, the Bureau of Commerce and Industry, supplemented by information received through inquiries from reliable persons, both Chinese and Filipinos, engaged in the business.

SOURCES OF PORK, KIND, AND QUALITY

As stated by Noguera (1918) and Manuel (1924), most of the hogs slaughtered in Manila come from the neighboring provinces of Rizal, Laguna, Bataan, Cavite, Batangas, Zambales, Bulacan, Pampanga, Tarlac and from the northern provinces of La Union, Ilocos Sur, and Pangasinan.

The number and weights of hogs coming from different sources could not be determined exactly as the dealers keep no record of their business. They keep no record of the number of hogs, or their source, nor do they weigh the hogs, they only estimate the live weight when buying.

In each locality the hogs are bought by local dealers and brought to Manila by them. In the city the Manila *compradores* buy the hogs from the provincial dealers. The Chinese retailers or stall owners in the markets buy the pigs from the *compradores* a few hours before they are sent to the slaughter-house.

Table 1 shows the number of hogs slaughtered in the city Matadero from November, 1923, to October, 1924, inclusive.

PEOPLE ENGAGED IN THE PRODUCTION OF PORK

The writer visited some of the towns in the neighboring provinces of Manila, but observed no specialization of the swine industry. Practically all the hogs shipped to Manila are from small herds raised on the side or as part of the family industry.

The records of the Bureau of Agriculture show that most of the hogs coming into Manila are from Batangas, Cavite, Rizal, Laguna, Pampanga, Bulacan, Ilocos, and Pangasinan. No record is kept as to the number of hogs supplied by each of these provinces. Most of these hogs are raised

without pens or shelter and are fed the kitchen refuse. There is a hog farm at the Santa Mesa Dairy Farm near Manila and the writer was informed that at one time there was one in Stotsenberg, Pampanga. The writer visited the farm in Santa Mesa as well as other smaller hog industries in Pasay. The owners claim that they have been making some profit in the business. Quite a few invested in pure breeds but lost money as the hogs died from kidney worms. One man in particular with a farm in Santa Maria, Bulacan, attributes his failure to this disease. His experience corroborates the report of Gonzalez and Lago (1924) on pure breeds of hogs in the Islands.

TABLE 1

Showing the number of hogs slaughtered in the Azcarraga matadero from November, 1923, to October, 1924 [a]

MONTH	BARROWS		SOWS AND PIGS		CONDEMNED	
	Number	Kilograms	Number	Kilograms	Number	Kilograms
November	8,983	300,361	1,056	34,845	82	3,383
December	9,700	331,386	1,061	36,059	124	4,891
January	9,323	296,891	968	32,171	82	3,275
February	8,922	278,716	937	30,956	48	1,844
March	9,206	288,279	960	30,834	59	2,380
April	8,584	208,027	898	28,647	69	2,886
May	8,715	336,593	891	28,865	77	2,974
June	8,686	315,532	888	28,178	92	4,140
July	9,008	287,619	898	29,141	84	3,453
August	9,221	354,474	——	——	74	2,421
September	9,995	190,603	804	31,065	105	4,796
October	9,704	388,446	280	39,806	59	2,644
Totals	110,047	3,576,927	9,641	350,567	955	39,087
Average weight		32.5		36.4		40.9

[a] From the records of the Market Division, City of Manila.

Management. As a rule, there is no selection made of the stock for breeding. Generally, the smallest pig in the litter is kept for breeding, not because it is believed to be a good breeder, but because it cannot be sold to advantage. The healthy vigorous individual is sold to neighbors in need of a garbage consumer and, if male, is castrated and raised for the market. The boars are allowed to run at large and as a result the sows are bred early, before they attain full maturity. In the selection of sows for breeding some points are usually considered, such as the number of teats, but no attention is paid to size and conformation. As a result of this uncontrolled breeding, and breeding from inferior individuals, the pigs marketed in Manila are generally small and poor in condition.

Castration. Castration of pigs is practiced. All the growing boars to be disposed of are castrated when about thirteen to eighteen weeks old.

Two parallel slits are made through the scrotum and the testicles forced out, then the spermatic cord is cut. In general, no antiseptic is used though sometimes wood ash, coconut oil, salt, or petroleum is applied. Usually, however, the wounds are left to heal by themselves.

Spaying. Spaying is seldom practiced. However, the writer was able to see how they spayed a sow. The animal operated upon was two years old. A cut was made on the upper part of the flank at the right side and the fingers were inserted to find and pull out the ovaries. A cord was tied just back of the point where the cut was made to remove the ovaries. The opening on the flank was sewed up.

FEEDS AND FEEDING

Among the most common feeds are: rice bran, corn, banana stalk, copra meal, or *paliat*, *puñgapong* (*Amorphophalus campanulatus*), cassava, *kiapo* (*Pistia stratiotes*), *kolites* (*uray*) (*Amaranthus viridis*), and *ulasiman* (*Portulaca oleracea*). The hogs are usually fed in a wooden trough morning and afternoon. Banana stalk, *puñgapong*, cassava, *kiapo*, *kolites*, and *ulasiman* are cooked before feeding them to the hogs.

THE MIDDLEMEN

The writer visited the pens of the Azcarraga matadero and made inquiries as to the men engaged in the business with the object of finding out the kind and number of middlemen.

The middlemen may be classified into local dealers, Manila dealers, or *compradores*, who are the pen keepers at the Azcarraga matadero, and retailers, or the owners of market stalls. Sometimes a *comprador* acts as a local dealer or he sends men out to the provinces. The main objection to this plan is that usually the *comprador*, or his agent, can not buy the pigs as cheap as can local dealers who know the conditions of the locality. The market retailers buy directly from the *compradores*. Occasionally, other middlemen act between the *compradores* and the market retailers.

The writer endeavored to determine exactly the distribution of profits among the men engaged in the raising and buying and selling hogs. But as no accounts of the business transactions are kept it was impossible to obtain definite information on which to base calculations. According to some of the men engaged in the business, the weight of the pigs is roughly estimated. From custom rather than market quotations the local dealer and the producer come to terms at from 35 to 45 centavos a kilogram live weight. Local dealers take the pigs to Manila and sell them to the Manila dealers, or *compradores*, who keep the pigs usually from one to three days in their possession. It is reckoned that the *compradores* make from 22 to 36 per cent on the pigs in that brief period. From the *compradores* the Chinese and Filipino retailers buy the hogs at about 50 centavos a kilogram live weight. Occasionally when there is scarcity of meat and fish the price is as high as

₱1.00. The retailer pays for butchering. The retailer's price to the consumer is from ₱0.70 to ₱1.20 a kilogram.

TABLE 2

Showing the average yearly retail prices of pork in the Manila markets [a]

YEAR	AVERAGE YEARLY PRICES PER KILOGRAM
1920	₱1.26
1921	₱1.21
1922	₱0.95
1923	₱0.93
1924	₱0.92

[a] From records of the Chief, Division of Statistics, Bureau of Commerce and Industry.

TABLE 3

Showing monthly distribution of hog carcasses to the different Manila markets [a]

MONTH	MANILA MARKETS							TOTALS
	Divisoria	Quinta	Arranque	Paco	Sampaloc	Obrero	Tondo	
November	3,829	2,570	848	710	377	265	256	8,855
December	4,248	2,783	899	821	415	291	228	9,685
January	4,139	1,750	827	772	381	275	234	8,378
February	3,957	2,706	805	1,062	385	246	198	9,359
March	4,010	2,663	784	772	409	283	225	9,146
April	3,801	2,509	707	704	381	269	213	8,584
May	4,000	2,464	745	740	385	277	227	8,838
June	3,784	2,461	777	776	424	273	226	8,721
July	3,884	2,582	799	792	415	260	226	8,958
August	3,955	2,619	795	822	434	305	233	9,163
September	3,932	2,794	846	768	442	290	220	9,292
October	3,924	2,387	829	711	405	276	185	8,717
Totals	47,463	30,288	9,661	9,450	4,853	3,310	2,671	107,696

[a] From the records of the Market Division, City of Manila.

SEASONAL VARIATION OF PRICES

Table 2 shows the average price of pork for the years 1920-1924.

The average monthly price of pork during the year is fairly steady with a little rise during the rainy season, owing to the scarcity of fish and vegetables.

Table 3 shows the monthly distribution of hog carcasses among seven of the principal Manila markets. From this table it may also be seen that more pigs are consumed during the months of December, January, February,

and March than during the rainy season. This is probably because in these months the price of pork is a little lower than during the rainy season. (See table 7). As stated in the preceding paragraph the price of pork is always higher when there is scarcity of fish and vegetables.

INSPECTION OF CARCASSES

The inspection work is done by experienced meat inspectors. The inspection includes external examination and examination of the internal organs. The jowl is slit and examined for *Cysticercus cellulosæ* which is indicated by the presence of minute sacs containing a fluid. Animals found to have this parasite are condemned. The intestines are examined for intestinal parasites and the parts affected are condemned. When the hogs are tuberculous, the whole carcass is condemned if the disease is generalized, but, if localized, only the diseased parts are condemned and removed. With other diseases, as to whether the whole carcass is condemned or only parts, depends on the severity and nature of the disease. The condemned parts are placed in cylindrical tin cans and burned.

TABLE 4

Showing the causes and number of animals (whole carcasses) condemned [a]

CAUSES	MONTHS, 1923												TOTALS
	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Cysticercus	78	45	52	59	68	75	81	59	101	56	71	82	827
Tuberculosis	2	4	2	5	—	4	2	6	3	3	8	1	40
Hog cholera	—	1	1	1	1	3	2	4	1	2	4	2	22
Found dead	2	—	3	1	1	—	2	—	—	—	1	1	11
Emaciation	—	—	—	—	1	2	1	2	—	—	1	—	7
Icterus	—	—	1	—	—	2	—	—	—	—	—	1	4
Broncho-pneumonia	—	—	—	—	2	—	—	—	—	—	—	—	2
Septicemia	—	—	—	1	—	—	—	—	—	—	—	1	2
Aneurism	1	—	—	—	—	—	—	—	—	—	—	—	1
Worm infestation	—	—	—	1	—	—	—	—	—	—	—	—	1
Totals	83	50	59	68	73	86	88	71	105	61	85	88	917

[a] From the records of the Statistics Division, Bureau of Agriculture, Manila.

In table 4 are given for 1923: the number of whole carcasses condemned and the diseases responsible for the condemnation.

Carcasses which have been passed by the meat inspector are distributed among different vendors, after they are weighed and labeled. The label bears the name of the retailer, the market, and the stall number. The carcasses are delivered by a meat wagon owned by the City of Manila, but the

meat may be taken from the matadero by any other kind of conveyance at the option of the buyer, owner, or retailer. The delivery charges to any Manila market by the City wagon is ₱0.40 per dressed animal.

The pork retailers comprise both Filipinos and Chinese. Table 5 shows the number and nationalities of the 175 dealers in the different markets of Manila. These figures are essentially the same as those obtained by Manuel (1924).

TABLE 5

Showing the number of retail dealers of pork in the Manila markets [a]

MARKETS	RETAIL DEALERS	
	Filipino	Chinese
Divisoria	4	57
Quinta	2	29
Arranque	2	19
Paco	2	9
Sampaloc	—	15
Obrero	—	11
Santa Ana	—	7
San Andrés	—	4
Tondo	4	10
Totals	14	161

[a] From the records of the Market Division, City of Manila.

There are different retailers for the carcasses and for the entrails and head. The vendors of entrails handle the kidneys, intestines, liver, lungs, tongue, head, heart, and blood. The prevailing price at the time of this study, was for kidneys from 20 to 30 centavos for two, according to size; intestines, fresh cleaned, 20 to 30 centavos a kilogram; lungs, 5 centavos a kilogram; tongue, 50 to 60 centavos a kilogram; head, 30 to 35 centavos a kilogram; and heart, 20 to 30 centavos according to size. The prices were found to be almost constant during the different seasons of the year.

MARKET PRICES

According to the reports of the consignees in the different markets of Manila, pork carcasses are placed in three classes: first, second, and third. The writer visited the markets of Manila off and on observing the fluctuation of prices. The dealers have no fixed price for the different classes. Table 6 gives an idea of the range of prices. Table 7 presents the detailed observations in seven markets for the year covered by the report.

TABLE 6

Showing relative prices for different grades of carcasses in the different markets of Manila [a]

MARKETS	FIRST CLASS	SECOND CLASS	THIRD CLASS
Divisoria	₱0.90	₱0.80	₱0.70
Quinta	₱0.92	₱0.75	₱0.62
Arranque	₱0.90	₱0.80	₱0.67
Paco	₱0.97	₱0.90	₱0.80
Sampaloc	₱1.00	₱0.92	₱0.83
Obrero	₱1.00	₱0.90	₱0.80
Tondo	₱0.99	₱0.94	₱0.86

[a] From personal observation.

TABLE 7

Showing the monthly average prices observed during the whole year [a]

MONTHS	DIVISORIA	QUINTA	ARRANQUE	PACO	SAMPALOC	OBRERO	TONDO
November	₱0.85	₱0.90	₱0.90	₱0.90	₱0.90	₱0.92	₱1.00
December	₱0.90	₱0.90	₱0.90	₱0.90	₱0.90	₱0.90	₱0.90
January	₱0.90	₱0.90	₱0.90	₱0.90	₱0.90	₱0.90	₱0.90
February	₱0.85	₱0.90	₱0.90	₱0.90	₱0.90	₱0.90	₱0.90
March	₱0.80	₱0.80	₱0.85	₱0.90	₱0.90	₱1.00	₱0.90
April	₱0.80	₱0.80	₱0.85	₱0.90	₱0.90	₱0.90	₱0.90
May	₱0.85	₱0.90	₱0.90	₱0.95	₱1.00	₱0.90	₱0.90
June	₱0.95	₱0.95	₱1.00	₱1.00	₱1.10	₱1.10	₱1.00
July	₱0.95	₱1.00	₱1.00	₱1.10	₱1.00	₱1.10	₱1.00
August	₱0.95	₱0.95	₱0.90	₱1.00	₱1.00	₱1.10	₱1.10
September	₱0.90	₱0.90	₱0.90	₱1.00	₱1.00	₱1.00	₱1.00
October	₱0.80	₱0.90	₱0.90	₱0.95	₱0.90	₱0.95	₱1.00

[a] From personal observation.

In the smaller markets of Paco, Sampaloc, Obrero, and Tondo, the prices were approximately 10 centavos higher for the same grade of pork than in the larger markets.

Through observation and information, the writer found that pork costs about five to fifteen centavos a kilogram less in the afternoon, from about four to six o'clock, than in the morning. Considering that by afternoon the meat has dried considerably, the difference in price is really greater.

SUMMARY

1. The hogs brought in to supply the city of Manila are slaughtered in the Azcarraga matadero.

2. The hogs butchered in the city of Manila are obtained from nearby provinces.

3. Most of the hogs brought to Manila are of native stock.

4. All hogs consumed by the public are properly inspected. The most common cause for condemnation is *Cysticercus cellulosæ*.

5. Relatively more animals are condemned from June to September than in other months.

6. The large markets of the city receive most of the dressed carcasses.

7. There are more Chinese than Filipino dealers.

8. Pork can be purchased cheaper in the larger than in the smaller markets, and cheaper in the afternoon than in the morning.

9. There is very little seasonal variation in the supply and demand, or in prices.

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NOGUERA, JOSÉ. 1918. The hog industry of the Philippines with special attention to the provinces around Manila. The Philippine Agriculturist **7**: 84–90.

THE RELATION OF CERTAIN PHILIPPINE COMMERCIAL VARIETIES OF BANANAS TO THE WILT DISEASE DUE TO FUSARIUM CUBENSE EFS.[1]

G. O. OCFEMIA AND M. A. PALO
Of the Department of Plant Pathology

The banana plantation of Mr. José Ciota, a Spanish banana grower in Lalakay, Los Baños, Laguna, Philippine Islands, is planted chiefly to Latundan (*Musa sapientum* L. var. *cinerea* (Blco.) Teodoro). There are a very few scattered hills of Saba (*M. sapientum* L. var. *compressa* (Blco.) Teodoro) and other varieties. On April 15, 1925, Mr. Ciota said that the wilt disease was first noted in his plantation in 1923. He said that he obtained his suckers from the plantation of Mr. Inocencio Hernandez, a neighboring Spanish farmer. According to Mr. Hernandez the banana wilt disease has been present in his fields since 1920. Practically every hill of Latundan in the banana plantation of Mr. Ciota was infected in April, 1925. The affected plants were dying prematurely and the rest were producing very small unmarketable bunches of fruit. All stages of the wilt disease were exhibited. The characteristic yellowing and wilting of the leaves and the cracking of the pseudo-stems were well shown. The brown-colored bundles, the most reliable symptom of wilt infection, were always found when the pseudo-stems of suspected plants were cut across. Following the suggestion of Dean C. F. Baker of the College of Agriculture, 107 stools of infected Latundan in Mr. Ciota's plantation were dug up on September 21 and 22, 1925, to determine the relation of root grubs (*Cosmopolites sordidus* Germar) to the occurrence of the wilt disease. It was found that only eight out of 107 stools or 7.47 per cent had grubs in the roots. The holes vacated were replaced on September 23 and 24, 1925, with suckers of the following varieties which were obtained on September 18, 1925, from Santa Cruz, Laguna:

22 suckers of Buñgulan (*M. sapientum* L. var. *suaveolens* (Blco.) Teodoro.)
26 suckers of Inarnibal (*M. sapientum* L. var. *inarnibal* Teodoro.)
19 suckers of Lacatan (*M. sapientum* L. var. *lacatan* (Blco.) Teodoro.)
20 suckers of Saba.
20 suckers of Ternate or Gloria (*M. sapientum* L. var. *ternatensis* (Blco.) Teodoro.)

Planting was also started on the banana plantation of Mr. Inocencio Hernandez, but it was discontinued because Mr. Hernandez was more in-

[1] First progress report on the work on banana wilt in Lalakay, Los Baños, Laguna, P. I., in co-operation with a banana grower. Experiment Station contribution No. 382. Received for publication, July 14, 1926.

terested in filling his vacant lots than in determining the relation of different varieties of bananas to the wilt.

On account of the uneven age, size, and condition of the suckers used in 1925 the greater portion of the plants died during the dry season of 1926. From June 8 to 10, 1926, after the first hard rains, holes were dug to replace the dead plants. From June 15 to 17 suckers of Red and White strains of Latundan, Ternate or Gloria, Saba, Buñgulan and Lacatan were bought in Masaya, Laguna, from apparently wilt-free banana fields. These suckers were shipped to Lalakay on June 19 and planted on June 21. Only these six varieties were obtained as their fruits are the most common on the local markets.

The work is in progress and the condition of the plants in relation to wilt infection is examined once every month.

EXCHANGE NOTES

We have an absolutely clean slate here in the Philippines. There is ample material [for rubber growing] at hand, seed for nursery purposes from well-grown healthy trees, and many thousands of fine heavy yielding mother trees from which budwood can be secured. There are many well trained Filipinos from the College of Agriculture, University of the Philippines, the best school in the world teaching tropical agriculture, who are quite familiar with this sort of work.—J. W. STRONG.

—*The Planter* (Kuala Lumpur, F. M. S.)

Seventy-five farms in Carroll, Cass, Howard and Miami counties, Indiana, raising 1,540 acres of soybeans, obtained an average yield of 16.3 bushels per acre when the seed was planted in rows. On twenty-eight farms growing 440 bushels the yield was 13.6 bushels when the beans were sowed broadcast.

—*Successful Farming*,—Iowa.

There are two chief things that sap the life of people, young to old, viz., Malaria in the lowlands and Hookworm everywhere. Quinine is sold cheap at every Post Office, that is the specific for Malaria. All precautions should be taken to clear out breeding places of mosquitoes; a film of kerosene oil will prevent mosquitoes laying their eggs in small waterholes; in larger ponds and tanks there should always be the small fish called variously "Millions," "Ticky-Tickies," and "Bungoes," easily got, yet many people do not bother to put them in their ponds and tanks. These little fish eat the larvæ of the mosquitoes. All old tins, etc., which are flung away and can hold water and so breed mosquitoes, should be picked up and buried.

The Hookworm Campaign is doing inestimable good, but it cannot be carried on everywhere at once and then people should understand that they can become re-infected. There is a simple country antidote which should be used by everyone. The medicine now used for Hookworn is Chenopodium, as effective, if not more so, than Thymol. If is the oil of the seed of a plant common here, usually called "Semi Contract" or Worm weed. If children were regularly dosed with a tea brewed from the leaves of this, we have been told, such homeopathic doses prevent infection of Hookworm. The late Dr. Strachan thoroughly believed in this and had reasons for his belief.

—*The Journal of the Jamaica Agricultural Society*, (Jamaica).

The pasteurization of dairy by-products such as whey and skim milk improves their feeding value and prevents the dissemination of disease among live stock..... The destruction of pathogenetic organisms in them protect the calves and pigs to which they are fed from contagious diseases. The pasteurization of whey also effects a more equitable distribution of it to the patrons of cheese factories, because in unpasteurized whey the fat rises quickly to the surface and as the whey is drawn from the bottom a large proportion of the fat remains in the tank.

—*Scientific Agriculture,* (Canada).

Another important phase of the agricultural situation in Palestine is the already largely successful campaign to drain swamps and rid the country of malaria. The budget of the Palestine Foundation Fund contains an item of $200,000 to continue this fight during the coming year; but, already in the historic valley of Jezreel, on land considered uninhabitable a few years ago because of malaria-carrying mosquitoes, 12 flourishing agricultural colonies have been established, and 20 colonies now occupy land in the valley of Esdraelon where a few years ago there were only malarial swamps and marshes.

—*Commerce Reports,* (Washington, D.C.)

On the Saturday nearest to his birthday, boy scouts annually make a pilgrimage to the grave of Theodore Roosevelt, the great citizen scout and warm friend of boys. By the grave stands a huge black Walnut tree, and one of the scout leaders, a year ago, gathered two of the nuts as they lay on the grass. Later his troop of boys seized upon them with joy, and, by care, succeeded in raising two sturdy seedlings, which will be set out this Summer. Since that day the boy scouts' enthusiasm has grown. Arrangements were made last Autumn with the sexton to secure more nuts, and now scout troops from Oyster Bay to the Pacific coast are planting walnuts from Roosevelt's grave. Someday there will be a living grove of trees stretching across the country, a beautiful symbol of the reverence and affection of boy scouts.

—*Gardener's Chronicle,* (New York).

The most complete grass garden in the United States is located at the University of California. In it are grasses from all parts of the world—India, Abyssinia, South Africa, New Zealand, Tasmania, Russia, Italy, Morocco, Mexico, Argentina, Bolivia, Brazil and other foreign countries. North America, which possesses about one-third of the total number of species in the world, is also well represented by the different kinds of blue, brome, bent, grama, alkali and other grasses from this and other states.

—*Cultivator,* (California).

COLLEGE AND ALUMNI NOTES

Mr. Carson Taylor, Publisher, and Mr. Roy Bennett, Editor of *The Manila Bulletin*, were visitors at the College on July 10. They came to see not to call, spending the whole day on the Campus, not in recreation but in investigation.

Those who remember the visit here of President Kenym L. Butterfield of Amherst (now of Michigan State) will be interested to learn that he is now attending the International Conference on Country Life at Brussels. It is expected that this Conference will meet in the United States in 1927.

Mr. C. E. Neff at one time instructor in English in the College spent a few hours on the Campus in July. He was on his way to the United States *via* Europe.

Dr. Eduardo Quisumbing has accepted a Fellowship from the National Research Council in Washington, D. C., to work on the flora of the Philippine Islands with Prof. Elmer D. Merrill, Dean of the College of Agriculture, University of California, Berkeley. Doctor Quisumbing, accompanied by Mrs. Quisumbing and their three children, sailed for the United States on August 14 on the S. S. *Empress of Asia*. Friends of the Quisumbings wish them a pleasant trip to and sojourn in the United States.

Mr. Deogracias Villadolid, M. S. '23, has been elected to the Sigma Xi. He was initiated on June 7 at the local chapter of Stanford University, California.

The Junior Agricultural Congress has resumed activities. A general convention is being planned to be held some time in the middle of September at which important agricultural problems of the Philippines will be introduced and discussed. Preparatory to this convention, the Congress has invited members of the Faculty and other experienced men outside of the College, to give lectures before the body on various questions pertaining to Philippine agriculture. These lectures will be open to all. The first lecture was given on Wednesday evening, July 14, 1926, by Dr. Toribio Vibar of the Department of Agronomy. The subject was "Objectives in Agricultural Education."

The student Dramatic Club opened its second year of activity with old members: J. Barsana, N. Florese, B. A. Huligañga, E. Lanuza, A. Muyargas, P. Ungos, G. Ventura, F. Villa, C. Villanueva, and M. Arnaldo. Ten who qualified in the try-outs for new members are: I. Abad, B. Hollero, V. Lopez, L. Joaquin, N. Pidlaoan, F. Basilio, F. Español, D. Cayabyab, C. Medrana, and P. Tugade.

The following officers were elected:

President - - - -	Brígido A. Huligañga
Vice-President - - - -	Agapito Muyargas
Secretary-Treasurer - - -	Paulino Ungos
Stage Manager - - - -	Marcelo Arnaldo
Business Manager - - -	Victoriano Lopez

The co-eds of the College of Agriculture are honorary and acting members of the club.

Miss Wilson is Director and Miss Whipple Assistant Director of the Club.

Claro Burgillos, member of Senior Class, after a short illness, died at Philippine General Hospital, June 15. Mr. Burgillos gave promise of a life of usefulness. He had shown his mettle by supporting himself, for the most part, during his five years in this College.